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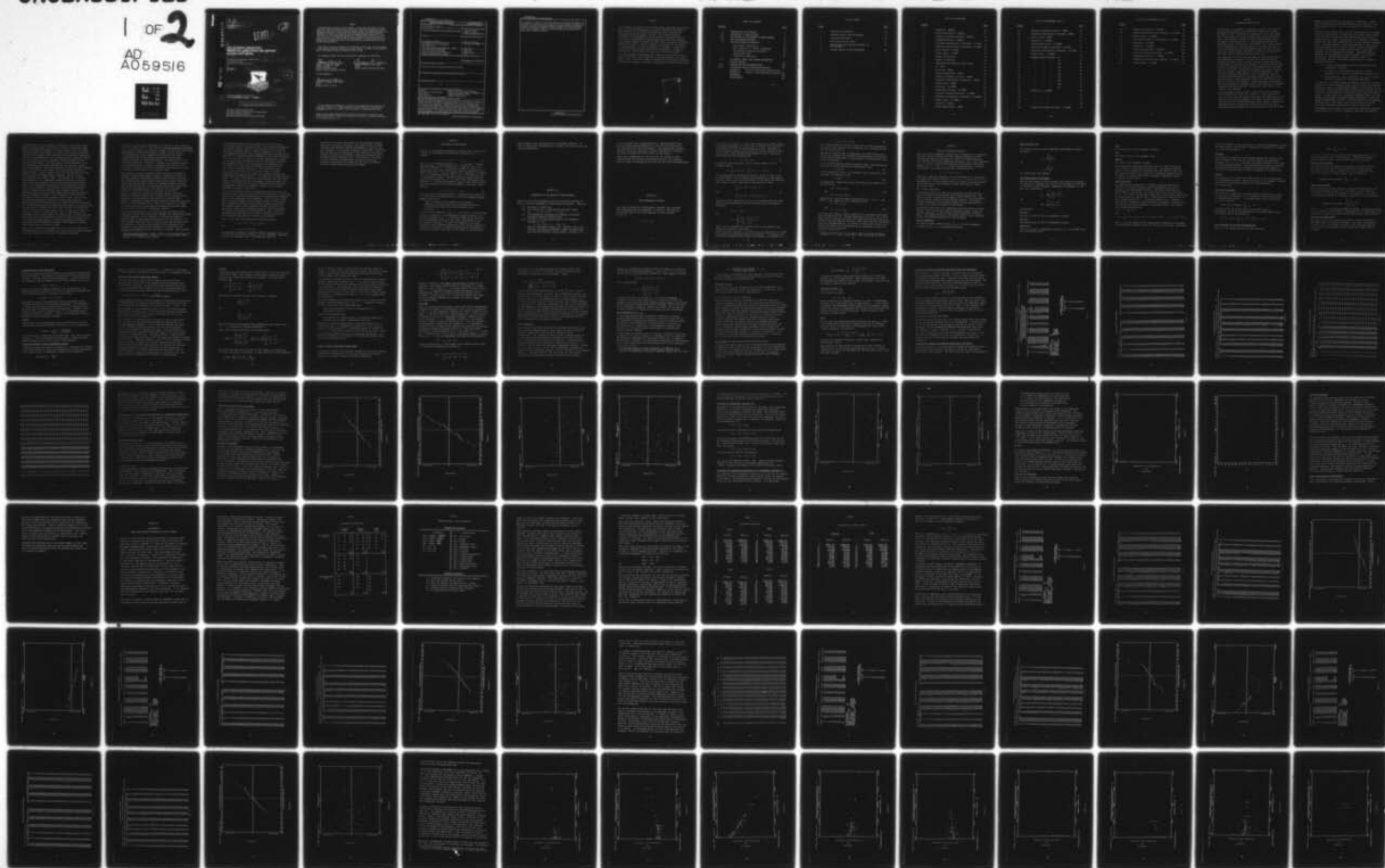
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(ALPOS) COST MODEL. Volume 2.**

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1111 SHILLING ROAD
HUNT VALLEY, MARYLAND 21031

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WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433

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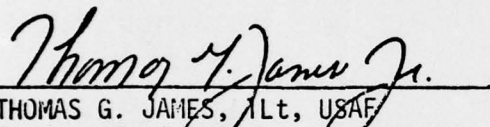
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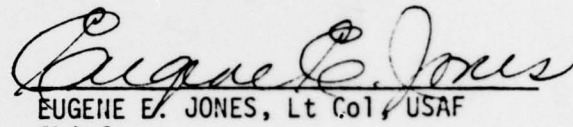
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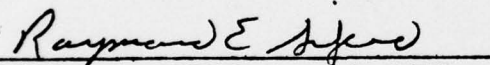
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THOMAS G. JAMES, 1Lt, USAF
Project Engineer
System Evaluation Group
Avionic Systems Engineering Branch


EUGENE E. JONES, Lt Col, USAF
Chief
Avionic Systems Engineering Branch

FOR THE COMMANDER


RAYMOND E. SIFERD, Lt Col, USAF
Chief
System Avionics Division

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This document is Volume II of the Final Report which describes the mathematical and statistical techniques used to obtain the cost estimating relationships and parametric estimating relationships needed to develop the Avionic Laboratory Predictive Operations and Support (ALPOS) Cost Model. The Air Force Program Monitor was Lt Thomas G. James, Jr., System Evaluation Group (AFAL/AAA-3), Avionic Systems Engineering Branch.

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PREFACE

This document is Volume II of the Final Report concerning the development of the Avionics Laboratory Predictive Operations and Support Model (ALPOS) by the Logistics Engineering Group, Westinghouse Integrated Logistics Support Division. This volume presents a discussion of the mathematical and statistical techniques used to obtain the cost-estimating relationships and parametric estimating relationships needed to develop the ALPOS Model, by means of Multiple Regression Analysis. Volume I presents a discussion of the "Design of the Experiment" and the development of the model, in addition to the model's source program listing and documentation. Volume III presents the consolidated data base used to develop the model.

The author wishes to acknowledge the technical contributions made by John P. Turek and E. Louis Wienecke in the development of the ALPOS Model. Also, the author wishes to acknowledge the computer programming assistance of Theresa B. Wallace of Westinghouse Logistics Engineering.

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SECTION I

INTRODUCTION AND OVERVIEW

Much research has been done in Government, Business, and Industry to obtain the capability to predict future occurrences (events). The need for such a capability is demonstrated by the time, money and, in some cases, lives, which can be saved using these predictions. For instance, studies are made to predict such things as the number of red blood cells in a blood sample based upon the packed-cell volume of the blood, the average grade a student makes on a standardized test based upon their I.Q.s, the death rate of males being exposed to the environmental conditions of a coal mine for over a 10 year period, the cost of a piece of avionics equipment based upon its physical characteristics, etc.

Past experience is usually the only means of predicting the future. The approaches to prediction can take forms ranging from hard objective evidence (which is rarely the case) to pure speculation. As an example of hard objective evidence, if you drop an apple from a cliff, most people will agree with the prediction that the apple will hit the ground. Accounting type models are useful estimating tools but require a large amount of detailed information. Such things as estimating the cost of a piece of equipment early in the conceptual/preliminary design phase, however, does not usually have the luxury of hard objective evidence or such detailed information on which to base decisions. Other approaches to prediction, such as the subjective approach, relies on the opinions of qualified experts in the field of study. And then of course, there is the "crystal ball" approach.

Once an estimate is made, however, there is an obvious question, "How accurate is the estimate?" Because of certain constraints (such as time, money and scope of the study) some approaches to estimation are the only ones possible, but there is a major drawback in that the merits of future predictions usually cannot be quantified. Mathematicians and statisticians have developed (and are still developing) many techniques for estimating purposes with particular

emphasis on quantifying the reliability of estimates. A major area of statistics that has been used for over a century is that of Regression Analysis. This is the approach to estimation we take.

Inherent in the interpretation of the words prediction or estimate is the term uncertainty. It would be nice to make "exact" predictions, but this is rarely the case when dealing with a mass of statistical data. Thus, statisticians do not profess to estimate exactly, but that their predictions are "on the average" reasonably close. The basic concept of Regression Analysis is then to estimate the average value of a given variable (called the dependent variable) in terms of the known values of one or more other variables (called independent variables). Regression Analysis expresses the relationships of these variables by determining the form of a mathematical equation connecting them. In other words, there are three major questions that are asked in Regression Analysis:

- (1) Is there a relationship between the dependent and the independent variables?;
- (2) If there is a relationship, how can it be "best" expressed in the form of a mathematical equation?; and
- (3) What statistics, plots, techniques, etc., can be used to verify the accuracy of the equation obtained?

For instance, if a study is made to estimate the average weight of a female in a given university based upon her height, the procedure would be to select a "representative sample" of the females in the university, record both their heights and weights (the data) and try to fit the "best" mathematical relationship that connects weight to height. In many cases, as in estimating equipment costs, one independent variable does not provide enough information to accurately predict the dependent variable. Considering additional independent variables can, in most cases, lead to more accurate estimates, since more information should lead to better predictions.

The purpose of this study is to estimate the Operations and Maintenance (O&M) cost of avionics equipment, based upon the physical

characteristics of the equipment in addition to any current information available (such as the type of aircraft in which the equipment is used and the equipment's avionics area) early in the conceptual/preliminary design phase. The tool used to estimate avionics O&M costs is a computer model developed by the Logistics Engineering Section of Westinghouse for the Air Force Avionics Laboratory (AFAL), and is called the Avionics Laboratory Predictive Operations and Support (ALPOS) Model. The ALPOS model is highly dependent on the six estimating relationships obtained for the logistics, support and cost parameters: Maintenance Manhours per Operating Hour (MMH/OH); Mean Time Between Failure (MTBF); Mean Time Between Maintenance Actions (MTBMA); Logistic Support Costs per Operating Hour (LSC/OH); Training Cost per Operating Hour (TRAIN/OH); and the fraction Not Repairable this Station (NRTS). The approach was to collect data consisting of 21 independent variables covering a wide spectrum of avionics equipment, develop Cost-Estimating Relationships (CERs), i.e. Regression equations where the dependent variable is cost (LSC/OH, TRAIN/OH), and Parametric Estimating Relationships (PERs), Regression equations where the dependent variable is a parameter which drives cost (MTBF, MTBMA, MMH/OH, NRTS) by means of Multiple Regression Analyses. Other parameters which drive O&M cost, such as spares cost and support equipment cost, are not estimated using regressions, since there are many other subjective variables affecting these parameters that cannot easily be quantified. The relationships obtained for MTBMA and NRTS, however, are used in conjunction with an Expected Back Order (EBO) criteria to estimate the quantity of spares and hence spares cost. The interested reader is referred to Vol.I of this report for a look at "The Design of the Experiment" and the development of the ALPOS model, in addition to the approaches used to estimate spares costs and support equipment costs. This volume is mainly devoted to the Multiple Regression Analysis techniques used to obtain the estimating relationships for MMH/OH, MTBF, MTBMA, LSC/OH, TRAIN/OH and NRTS.

Since the six parameters considered are major drivers of Operations and Maintenance Cost, much emphasis has been placed on finding the most up to date approach to the subject of Regression Analysis.

The major reference noted throughout this report is a book written in 1971 by C. Daniel and F. S. Wood entitled Fitting Equations to Data [1], out of which evolved a most powerful computer program called "The Linear Least-Squares Curve-Fitting Program" (LLSCFP). As will be seen, the sophistication of the approach and techniques used in [1] is far beyond that of any standard statistics books and many advanced textbooks on Regression Analysis. The innovative use of "interior" statistics, "Indicator" variables and computerized plots are extremely helpful in leading a qualified statistician in the direction of obtaining the "best" estimating relationships that can be obtained from a given set of multifactor data.

The proposals presented in [1] have been successfully discussed in seminars at many distinguished worldwide universities as well as the Bell Telephone Laboratories and the National Cancer Institute. The LLSCFP has also been the most sought after program in both the SHARE (IBM) and VIM (CDC) libraries of computer programs, and has also been converted to run in East Germany and Russia. These techniques have been applied in a wide range of areas including studies by government agencies of variables for pollution control, searches for influential variables which cause cancer, studies to estimate hospital costs, studies in the conservation of energy and the evaluation of moon rocks at the Johnson Space Center. In addition a Bureau of Labor Statistics study has shown that the coefficients estimated by the LLSCFP are accurate to 15 digits. It is felt then that the proposals and techniques presented in [1] are the "state of the art" in Regression Analysis.

A word of caution however, is in order, in that the LLSCFP is not idiot proof and the cost analyst must remember that Regression Analysis is highly dependent on the "goodness" of the data and maybe to a greater extent on the assumed functional form of the equation. For if the assumed functional form is incorrect then the statistics will be misleading, giving the wrong values of the coefficients to be estimated, making uninfluential variables seem influential and possibly even dropping the most influential variables. Many examples

¹ Fitting Equations to Data, Computer Analysis of Multifactor Data for Scientist and Engineers, C. Daniel and F. S. Wood with the assistance of J. W. Gorman, Wiley, (1971).

in Regression Analysis have an assured form of the estimating relationship based on a previous study or on technical knowledge of the process studied. However, there has been no previous study devoted to developing CERs for avionics equipment in as many as 21 independent variables, nor is enough known about avionics equipment that will lend to technical knowledge of the correct functional form. We must not stop here, but, should simultaneously consider all variables which are "assumed" to have an influential effect on the dependent variable, and let statistics and techniques lead the analyst in the direction of obtaining the equations that yield the best possible predictions. Many functional forms can be quite complicated, and for a given range of interest, transformations (such as, the square, the natural logarithm, the exponential, the square root, etc.) are often used to estimate these cases. To assist in obtaining the "best" possible equations, three forms or transformations of the independent variables (namely the variable, its square and its natural logarithm) and two forms of the dependent variable (the dependent variable and its natural logarithm) are used in this report.

It is to be emphasized that the independent variables are not considered one at a time or in pairs or any other grouping, but that they have all been considered simultaneously to determine their compound effect on the parameters to be estimated. It can be easily shown that a dependent variable can be highly correlated to one variable and no apparent correlation exists between another variable, but the compound effect of both variables (or many variables) has a significant effect on the dependent variable. Hence the practice of using scatter diagrams of the dependent variable versus each independent variable should not be used in determining the form of the equation when multiple variables are considered.

Thus, in this study such complicated functional forms as:

$$y = b_0 + b_1x_1 + b_2x_2^2 + b_3\ln x_3 + \dots$$

and

$$y = b_0 e^{b_1x_1} e^{b_2x_2^2} x_3^{b_3} \dots$$

are considered as means of estimating advanced equipment costs. Here y stands for the dependent variable, x_i 's the independent variables, b_i 's are the constants, and e the exponential function.

To assist in verifying the accuracy of the equations obtained, there are over thirty statistics, five types of plots, several techniques and different tabular arrangements of the data that are available in the computer printouts of the LLSCFP. This document includes a brief discussion of the concepts of Regression Analysis including the statistics, plots and techniques used to estimate advanced equipment costs. Also given, as an example, are the procedures and approaches utilized to obtain the parametric estimating relationship for the support parameter Mean Time Between Maintenance Actions (MTBMA).

SECTION II

THE METHOD OF LEAST-SQUARES

The form of the equations considered throughout this report can be written (or transformed) into the linear equation in $(\kappa + 1)$ - unknowns

$$y = \beta_0 + \beta_1 x_1 + \dots + \beta_\kappa x_\kappa \quad , \quad (1)$$

where y is the dependent variable, x_1, \dots, x_κ and the κ - independent variables, β_0 (the constant) and κ - coefficient $\beta_1, \dots, \beta_\kappa$ make up the unknown $(\kappa + 1)$ population parameters. Also it is assumed that there are N observations (pieces of equipment) in the sample indexed by j . Thus y_j represents the (observed) j th observation of the dependent variable and x_{ij} the j th observation of the i th independent variable. Regression Analysis requires that the analyst find statistics $b_0, b_1, \dots, b_\kappa$ which "best" approximates the unknown $(\kappa + 1)$ population parameters (where we have taken a sample from the population of all avionics equipment), and whose fitted equation

$$Y = b_0 + b_1 x_1 + \dots + b_\kappa x_\kappa \quad (2)$$

gives the "best" possible prediction. The method most widely used by statisticians to accomplish this is called the method of least-squares, which says:

"Find the values of the constants in the assumed equation that minimize the sum of the squared deviations of the observed values from those estimated by the equation."

In other words, minimize $Q = \sum_{j=1}^N (y_j - Y_j)^2$, where Y_j is the estimate of the j th observation of the dependent variable obtained by (2). Once the estimates $b_0, b_1, \dots, b_\kappa$ are found, substituting the values of the independent variables in (2) yields the estimate of the the dependent variable Y . We thus find ourselves in an area of statistics called "Inductive Statistics" which uses the concepts of "Statistical Inference" to make generalizations (or estimates) of population parameters based upon a given sample of the population,

and to quantify the reliability of the estimates obtained. In order to make these generalizations, however, the data must satisfy certain assumptions.

SECTION III

ASSUMPTIONS OF THE METHOD OF LEAST-SQUARES

There are four major assumptions which the data must satisfy in order to use the techniques of least-squares estimation. They are:

- A1. The data is "good" data.
- A2. The correct form of the equation has been chosen.
e.g., $y = \beta_0 + \beta_1 x_1 + \dots + \beta_k x_k$
- A3. The independent variables are constant, non-random variables, measured without error.
- A4. All error is in the observations of the dependent variable y_j , i.e.

$$y_j = \beta_0 + \beta_1 x_1 + \dots + \beta_k x_k + e_j$$

where e_j represents random error. Moreover, the e_j are normally distributed independent random variables with mean zero and constant, though unknown, variance $\sigma^2(y)$.

If all the above four assumptions hold or "approximately" hold, then the least-squares approach will give the best estimates of the coefficients in the relationships. Past experiences, however, indicate that slight departure from the assumptions of normality and equal variances has little effect on the results.

Since these assumptions are the basis for the method of least-squares estimation and hence Regression Analysis, much emphasis must be placed in determining how close the data fits the assumptions.

SECTION IV

ONE INDEPENDENT VARIABLE

Very often in practice a relationship connecting two variables (one independent and one dependent) is desired. The equation most widely used is the linear equation (in two unknowns β_0 and β_1),

$$y = \beta_0 + \beta_1 x_1 \quad .$$

If all pairs of values of x_1 and y , when plotted in a scatter diagram on ordinary graph paper, fall on or near a straight line, equation (3) is the correct form of the relationship to be used. According to the least-squares criteria, we must use the data to calculate statistics b_0 and b_1 which estimate the parameters β_0 and β_1 , and whose fitted equation can be expressed by

$$y = b_0 + b_1 x_1 \quad (4)$$

In addition, the statistics b_0 and b_1 must be chosen so as to minimize Q where:

$$Q = \sum_{j=1}^N (y_j - \bar{y}_j)^2 = \sum_{j=1}^N (y_j - b_0 - b_1 x_{1j})^2 \quad (5)$$

By the techniques of differential calculus, the way to find b_0 and b_1 which minimize Q is to take partial derivatives of Q with respect to both b_0 and b_1 , set the results equal to 0 and solve the equations for b_0 and b_1 . Thus, taking partial derivatives we obtain

$$\sum_{j=1}^N (y_j - b_0 - b_1 x_{1j}) = 0$$

and

$$\sum_{j=1}^N (y_j - b_0 - b_1 x_{1j}) (x_{1j}) = 0 \quad (6)$$

Solving the first equation of (4) for b_0 and substituting the results into the second equation yields the following linear least-squares estimates:

$$b_0 = \bar{y} - b_1 \bar{x}_1$$

and

$$b_1 = \frac{\sum_{j=1}^N (x_{1j} - \bar{x}_1) (y_j - \bar{y})}{\sum_{j=1}^N (x_{1j} - \bar{x}_1)^2} \quad (7)$$

where \bar{y} and \bar{x}_1 represent the arithmetic mean of the dependent and independent variables respectively.

Scatter diagrams, however, do not always give an indication of an linear relationship, but show some evidence of curvature. For instance, the graph might indicate that the form of the equation is a parabola, i.e.,

$$y = \beta_0 + \beta_1 x_1 + \beta_1 x_1^2 \quad (8)$$

If a linear equation is fitted to data that is better represented by a curvilinear equation, then assumption A2 is volidated and the results can be spurious.

The use of a special type of graph paper (for which either one or both of the variables are calibrated logarithmically) called semi-log or log-log graph paper, is also helpful in choosing other forms of the relationship.

If in a scatter diagram plotted on semi-log paper, the observations fall near a straight line, then the exponential curve,

$$y = \beta_0 e^{\beta_1 x_1} \quad (9)$$

is the appropriate choice. If a straight line is obtained on log-log paper, the geometric curve,

$$y = \beta_0 x_1^{\beta_1} \quad (10)$$

is appropriate. Taking the natural logarithm of both sides of (9) and (10) yields

$$\ln y = \ln \beta_0 + \beta_1 x_1 \quad (11)$$

and

$$\ln y = \ln \beta_0 + \beta_1 \ln x_1$$

respectively. Using the simple transformation $y' = \ln y$, $x' = \ln x_1$ and $\beta'_0 = \ln \beta_0$, equation (11) is transformed into

$$y' = \beta'_0 + \beta_1 x_1$$

and

$$y' = \beta'_0 + \beta_1 x'_1 \quad (12)$$

which are both similar in form to equation (3), and whose coefficients can be estimated by (5). Thus, any functional forms (e.g. (8) or (9)) which can be linearized by simple transformations fall under the realm of least-square estimation techniques. Many other plots of linearizable equations (see [1] and [2]) are also useful in finding the correct functional relationship to be used when only one independent variable is considered to be influential.

² "Fitting Curves to Data," A. E. Horel, Chemical Business Handbook (edited by J. H. Perry), McGraw-Hill, 1954, Section 20, pp. 55-77.

SECTION V

MULTIPLE REGRESSION ANALYSIS

When two or more independent variables are considered in a regression exercise, scatter diagrams and other graphical methods are often useless when trying to determine the form of the assumed equation. For instance, if the two independent variables x_1 and x_2 are considered, an $x_1 - y$ scatter diagram might indicate a high linear relationship whereas the $x_2 - y$ and $x_1 - x_2$ scatter diagram may show no apparent correlation, even though the true form after equation is

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 .$$

Therefore, graphical techniques are not considered as an alternative to finding the correct form of the equation to be tested (as required by assumption A2). If the correct form is not known, the analyst should try several forms of the equation, and let the statistics verify the correct form.

THE "GLOBAL" STATISTICS

As stated previously, in addition to estimating the coefficients, a means is needed to determine how "good" these estimates are. The statistics used to verify the "goodness of fit" of the relationships will be briefly defined with some general comments. The capital letters correspond to the respective names of these statistics as listed in the computer printouts of the LLSCFP.

We initially begin with a few elementary statistics which are quite helpful. They are the sums, means, maximums, minimums, ranges and standard deviations of the variables (both independent and dependent). With these statistics, the analyst can get a good indication of the distributional properities of the variables.

SUMS OF VARIABLES

The computer LLSCFP lists the sum, $\sum_{j=1}^N x_{ij}$, for each independent variable and $\sum_{j=1}^N y_j$ for the dependent variable.

MEANS OF VARIABLES

The arithmetic mean of each independent and dependent variable denoted by

$$\bar{x}_i = \frac{\sum_{j=1}^N x_{ij}}{N}$$

and

$$\bar{y} = \frac{\sum_{j=1}^N y_j}{N}$$

are listed under this heading.

ROOT MEAN SQUARES OF VARIABLES

The root mean squares of the variables (also called the standard deviation) is a statistic that can give an indication of the spread or variation of each variable, independent and dependent, in the data and is denoted by

$$s_{x_i}^2 = \frac{\sum_{j=1}^N (x_{ij} - \bar{x}_i)^2}{N - 1}$$

and

$$s_y^2 = \frac{\sum_{j=1}^N (y_j - \bar{y})^2}{N - 1}$$

respectively.

MAX X(I)

The maximum value of the *i*th independent variable.

MIN X(I)

The minimum value of the *i*th independent variable.

RANGE X(I)

The range of the *i*th independent variable, i.e., the maximum value minus the minimum value.

MAX Y

The maximum value of the dependent variable.

MIN Y

The minimum value of the dependent value.

RANGE Y

The range of the dependent variable.

Many times these elementary statistics can give a quick indication that something is wrong with the data (e.g., an impossible maximum value). Recall Assumption A1 specifies that the data is "good" data. The simple statistics can be helpful in pinpointing which particular variables are causing such things as outliers (impossible values) to develop in the results.

COEFFICIENT B(I)

The least-squares estimates of a multiple regression equation are obtained in a similar fashion as those estimated for the linear-equation in one independent variable. The partial derivative of Q with respect to the constant b_0 is taken and set to zero and solved for b_0 . This result is then substituted into Q where partial derivatives of Q with respect to each of the κ - coefficients are taken and set to zero, thereby yielding a $\kappa \times \kappa$ system of equation in κ - unknowns. This system of equations is then solved by the methods of determinants to determine the desired estimates of the coefficients. The linear-least squares estimates are:

$$b_0 = \bar{y} - \sum_{i=1}^{\kappa} b_i \bar{x}_i$$

and

$$b_i = \sum_{j=1}^N y_j \{c_{i1} (x_{1j} - \bar{x}_1) + c_{i2} (x_{2j} - \bar{x}_2) + \dots + c_{i\kappa} (x_{\kappa j} - \bar{x}_\kappa)\}$$

where c_{ij} is the element of the inverse matrix (obtained by the method of determinants) belonging to the i th row of the j th column. The LLSCFP

lists the constant b_0 and a coefficient b_i for each independent variable. The coefficient b_i can be used to determine the influence of variable x_i on the fitted equation.

RESIDUAL

The residual is defined as the difference between the observed value of the dependent value and the value estimated by the prediction equation, i.e., $y_j - Y_j$. Note that this simple statistic is the basis for least-squares analysis. Once the prediction equation is obtained, the residuals show how well the equation estimates the dependent variable for each observation (piece of equipment) in the data base.

FITTED Y

The statistic Y_j is called the fitted y-value of the jth observation of the dependent variable. This is the value of the dependent variable estimated by the prediction equation for each observation in the data base.

TOTAL SUM OF SQUARES

The total sum of squares in an initial step is trying to get a grip on the error of prediction. It is a measure of the total variation in the dependent variable. It is proportional to S_y^2 , the variance of y and is defined:

$$\text{TOTAL SUM OF SQUARES} = \sum_{j=1}^N (y_j - \bar{y})^2 .$$

The total sum of the squares can be partitioned into two useful sums, the sum of the squares due to the fitted equation and the residual sum of the squares, i.e.

$$\sum_{j=1}^N (y_j - \bar{y})^2 = \sum_{j=1}^N (Y_j - \bar{y})^2 + \sum_{j=1}^N (y_j - Y_j)^2$$

SUM OF SQUARES DUE TO THE FITTED EQUATION

The sum of the squares due to the fitted equation,

$$SSFE = \sum_{j=1}^N (Y_j - \bar{y})^2$$

is that part of the total variation in the dependent variable y that can be attributed to the fitted equation. A large SSFE indicates that the equation used is accounting for most of the variation.

RESIDUAL SUM OF SQUARES

The residual sum of the squares is that part of the total variation that cannot be attributed to the fitted equation (such things as experimental error, chance, function bias, i.e., having the wrong form of the equation, or other biases), and is defined as

$$\text{RESIDUAL SUM OF SQUARES} = \sum_{j=1}^N (y_j - Y_j)^2$$

RESIDUAL MEAN SQUARE

Recall Assumption A4 states that the y -observations have the same constant though unknown variance $\sigma^2(y)$, and hence, we need a means of estimating this variance of prediction. One estimate of $\sigma^2(y)$ called the residual mean square (or variance), denoted by $S^2(y)$, is defined as

$$\text{RESIDUAL MEAN SQUARE} = \frac{\sum_{j=1}^N (y_j - Y_j)^2}{N - \kappa - 1}$$

where $N - \kappa - 1$ is the RESIDUAL DEGREES OF FREEDOM. The degrees of freedom of a statistic is the number of independent bits of observations minus the number of parameters estimated in the calculation of the statistic.

RESIDUAL ROOT MEAN SQUARE

The square root of the residual mean square is called the RESIDUAL ROOT MEAN SQUARE (or standard deviation). This can be interpreted in a similar way as the standard deviation of the prediction equation. The residual root mean square is also called the Standard Error of Estimate.

STANDARD ERROR OF THE COEFFICIENT

Since each of the coefficients obtained by the method of least-squares are only estimates, the accuracy and importance of each estimate must be shown. From the equation which calculates b_i , it can be shown that the variance of the b_i , denoted by $S^2(b_i)$ can be written in the form

$$S^2(b_i) = S^2(y) C_{ii} ,$$

where C_{ii} is the i th diagonal element of the inverse matrix. The square root of the variance of b_i , $S(b_i)$, is called the standard error of the coefficient and is calculated by the formula

$$S.E.COEF. = S(y) (C_{ii})^{\frac{1}{2}} .$$

The standard error of the coefficient gives an indication of the "inherent" precision of the coefficient estimated. If a coefficient is large, say 1,000 with a standard error of .1, we could say that the coefficient is estimated with great precision. However, a coefficient of say .2 with a standard error of .1 is obviously not as precise an estimate. Therefore, a means of determining the relative accuracy of each coefficient is needed.

T-VALUE

The statistic used to measure the relative accuracy of each of the coefficients is called the T-VALUE (denoted by t_i) and is defined by

$$T\text{-VALUE} = \frac{b_i}{S(b_i)} = \frac{\text{COEF } B(I)}{S.E.COEF.}$$

The LLSCFP lists a T-VALUE for each coefficient. The larger the coefficients t_i - value (as compared with the other t -values), the more chance variable x_i will be in the final fitted equation.

RELATIVE INFLUENCE OF EACH INDEPENDENT VARIABLE

A statistic called the relative influence of x_i , describes the fraction of the total change in Y that can be accounted for by the accompanying total change in the i th independent variable and is defined as

$$REL.INF.X(I) = \frac{b_i w_i}{w_y} ,$$

where $b_i \equiv \text{COEF } B(I)$ is the coefficient, $w_i = \text{RANGE } X(I)$ is the range of the independent variable and w_y is the range of the dependent variable.

MULTIPLE CORRELATION COEFFICIENT SQUARED

The total sum of the squares, sum of squares due to the fitted equation and residual sum of the squares will have different values for different equations. The most widely used statistic which gives a relative measure of the "goodness of fit" of the assumed equation is the multiple correlation coefficient squared (denoted by R_y^2) where

$$\text{MULT. CORREL. COEF. SQUARED} = \frac{\text{SSFE}}{\text{TOTAL SUM OF SQUARES}} \cdot$$

The multiple correlation coefficient squared (also called the coefficient of determination) is defined as that fraction of the total sum of the squares that can be attributed to the fitted equation. If $R_y^2 = 1$ we are fortunate to have a "perfect" fit and if $R_y^2 = 0$ the fitted equation does not fit the data at all. In most cases the multiple correlation coefficient squared will fall between the values of 0 and 1, and here interpretation is necessary.

For instance, if a straight line is fitted to a pair of data points when the correct form of the equation should be exponential (i.e., a logged dependent variable), a low R_y^2 does not indicate that there is "no" relationship between the data, but that the relationship used does not adequately represent the data. Thus the multiple correlation coefficient squared measures the degree of the relationship relative to the equation used. Sometimes, however, a large R_y^2 such as .90 can occur when the wrong form of the equation is chosen (examples will be given). Therefore a specific value of R_y^2 that indicates a "good" fit is not given. Although the multiple correlation coefficient squared is the most widely used statistic that measures the accuracy of the relationships, it means very little to this analyst when considered alone. It should be considered in conjunction with all other statistics, graphical representations of goodness of fit, and techniques used to determine the stability of the equations.

F-VALUE

A statistic used to determine the "significance" of R_y^2 is the statistic called the F-VALUE. The F-VALUE is usually used to judge the equivalence of two independent estimates of variance. It can be easily be shown that

$$R_y^2 = \frac{\sum_{j=1}^N (Y_j - \bar{y})^2}{\sum_{j=1}^N (y_j - \bar{y})^2} = 1 - \frac{\sum_{j=1}^N (y_j - Y_j)^2}{\sum_{j=1}^N (y_j - \bar{y})^2}$$

and therefore indicates that the two estimates of variance

$$\frac{\sum_{j=1}^N (Y_j - \bar{y})^2}{\kappa}$$

and

$$\frac{\sum_{j=1}^N (y_j - Y_j)^2}{N - \kappa - 1}$$

should be helpful in determining the significance of R_y^2 , where κ and $N - \kappa - 1$ are degrees of freedom respectively.

Hence, the F-VALUE is defined by the variance ratio,

$$F\text{-VALUE} = \frac{\frac{\sum_{j=1}^N (Y_j - \bar{y})^2}{\kappa}}{\frac{\sum_{j=1}^N (y_j - Y_j)^2}{N - \kappa - 1}} = \left(\frac{N - \kappa - 1}{\kappa} \right) \frac{\sum_{j=1}^N (Y_j - \bar{y})^2}{\sum_{j=1}^N (y_j - Y_j)^2},$$

which indicates that the larger SSFE is with respect to RESIDUAL SUM OF SQUARES, the larger the F-VALUE. An equivalent form of the F-VALUE is

$$F\text{-VALUE} = \left(\frac{N - \kappa - 1}{\kappa} \right) \frac{R_y^2}{(1 - R_y^2)}.$$

If R_y^2 is close to 1 then $1 - R_y^2$ is close to 0 and the F-VALUE is large. Of course the question must be answered, "How large is large enough?" This question can be answered by performing the statistical hypothesis test called the F-Test.

In performing a statistical test, a level of significance is usually assumed, denoted by the Greek letter α . The level of significance is the amount of risk that the analyst is willing to take in rejecting a true hypothesis. The values of α which are usually assumed are .05 (The test would be called "probably significant" and further experimentation may be in order.) and .01 (The test is called "highly significant."). Throughout this report $\alpha = .01$ is the assumed level of significance.

The F-Test compares the F-VALUE with values from an F-Table (in most standard statistics books) with κ and $N - \kappa - 1$ degrees of freedom, to give a joint test of the hypothesis that:

"all the coefficients of the fitted equation are 0"
(indicating a bad fit).

against the alternative that

"the equation as a whole produces a significant reduction in the total sum of square" (indicating a good fit).

Suppose for a given fit the F-VALUE = 10.8 where there are $N = 15$ observations and $\kappa = 3$ independent variables ($\alpha = .01$). From an F-table, a value (based on $\kappa = 3$ numerator degrees of freedom and $N - \kappa - 1 = 11$ denominator degrees) of 6.22 can be extracted. Since 10.8 is greater than 6.22 the fit is considered significant. The larger the F-VALUE is with respect to its associated tabular value, the more significant the fit.

SIMPLE "LINEAR" CORRELATION COEFFICIENT

A statistic (similar to the multiple correlation coefficient squared) which gives an indication of how any two variables are linearly related is the simple "linear" correlation coefficient

$$r_{12} = \left(\frac{\sum_{j=1}^N (x_{1j} - \bar{x}_1) (x_{2j} - \bar{x}_2)}{\sqrt{\sum_{j=1}^N (x_{1j} - \bar{x}_1)^2 \sum_{j=1}^N (x_{2j} - \bar{x}_2)^2}} \right)^{\frac{1}{2}}$$

which is a measure of the linear interdependence between any two variables. The simple linear correlation coefficient is a number between -1 and +1, where $r_{12} = 1$ indicates positive linear correlation, $r_{12} = -1$ indicates a negative linear correlation, and $r_{12} = 0$ indicates that there is no linear relationship between the two variables. Again, note that $r_{12} = 0$ does not indicate that there is "no" correlation between the variables, but that no linear correlation exists.

R(I) SQRD

There are obviously many problems in which more than two independent variables are assumed to be influential, and it is very informative to see how all the independent variables are linearly related to each other. A statistic (which is a generalization of r_{12}) that gives an indication of how the i th independent variable is linearly related to all the other $(\kappa - 1)$ - independent variables, is the squared multiple "linear" correlation coefficient R_i^2 . Here with variable x_i as the dependent variable and the remaining $(\kappa - 1)$ independent variables, we fit a simple linear equation and calculate the multiple correlation coefficient squared which is R_i^2 . Thus R_i^2 measures the degree of linear dependence of x_i on the other $x_{i'}$, $i' \neq i$, where $R_i^2 = 1$ indicates that a strong linear relationship between x_i and the other $x_{i'}$'s. If only two independent variables are considered then

$$R_1^2 = r_{12}^2 = r_{21}^2 = R_2^2$$

It can be shown that c_{ii} (the element of the inverse matrix in the i th row and j th column) may be written as

$$c_{ii} = \frac{1}{\sum_{j=1}^N (x_{ij} - \bar{x}_i)^2 (1 - R_i^2)}$$

This leads to a relationship between the standard error of the coefficient b_i , $s(b_i)$ (S.E.COEF) and the squared multiple linear correlation coefficient, R_i^2 (R(I)SQUARED), namely

$$s(b_i) = \frac{s(y)}{\sqrt{\sum_{j=1}^N (x_{ij} - \bar{x}_i)^2 (1 - R_i^2)}} .$$

With the form of the equation chosen, $s(y)$ and $\sum_{j=1}^N (x_{ij} - \bar{x}_i)^2$ are constant and determined by the data, and R_i^2 therefore determines the size of $s(b_i)$. If R_i^2 is close to 1, then $1 - R_i^2$ is close to 0 which increases the size of the standard error of the coefficient, $s(b_i)$. A large $s(b_i)$ will result in a small t_i -value, thus possibly dropping x_i from the set of influential variables to be used in the final prediction equations. Some independent variables are simply uninfluential in their effect on the dependent variable and will be dropped (by using a technique called the Cp-search technique), while other independent variables may be so highly correlated (linearly) to the remaining independent variables that their effects on the dependent variable can be explained by the remaining variables.

THE D-STATISTIC

Many times the statistics and plots will indicate some form of lack of fit of the assumed equation. This lack of fit may be caused by having the wrong form of the equation, sometimes called function bias. For instance, we may be fitting a straight line to a set of paired data when actually a parabola is the correct form, i.e., a squared term is needed in the equation. If the statistics and plots indicate that curvature in a particular variable x_i is needed, x_i^2 can be used as an additional independent variable. Usually $(x_i - \bar{x}_i)$ and $(x_i - \bar{x}_i)^2$ can be used as independent variables to reduce the high correlation between x_i and x_i^2 , resulting in an unwanted large R_i^2 . Sometimes, however, the mean \bar{x} does not sufficiently reduce the high correlation between a variable and its square. A

statistic d_i (called the d-statistic) due to O. Dykstra [1], which requires that the covariance between $(x_i - \bar{x})$ and $(x_i - d_i)^2$ to be zero, can be used to reduce such high correlations. This reduces to solving

$$\sum_{j=1}^N (x_{ij} - \bar{x}_i) (x_{ij} - d_i)^2 = 0$$

for d_i , which yields

$$d_i = \frac{\sum_{j=1}^N x_{ij}^2 (x_{ij} - \bar{x})}{2 \sum_{j=1}^N (x_{ij} - \bar{x}_i)^2} .$$

In this case we use $(x_i - \bar{x})$ and $(x_i - d_i)^2$ as the independent variables. If \bar{x}_i is used instead of d_i , a large R_i^2 for either the variable or its square may occur, thereby possibly dropping the variable and/or its square as being uninfluential variables, when in fact both may be influential variables. Through this report, the d_i -statistic is used if there is an indication of curvature in the relationships.

THE CP-STATISTIC, $P = \kappa + 1$

In many cases when multiple variables are considered, not enough previous work has been done in the area of study to be sure that all the independent variables are influential, but that possibly a subset collection of the variables fit the data "better" or as "good" as the initial set. If there are $\kappa = 18$ independent variables, then there are $2^{18} = 262,144$ possible combinations of variables whose equation must be compared.

A major innovative statistic due to C. Mallows ([1] and [3]) called the C_p -statistic, is used as a measure of "goodness of fit" to compare all the possible 2^κ combinations of equations for the "set" of equations which best fits the data. The C_p -statistic represents the "total squared error (random squared error and bias squared error)" and is defined as

³ "Choosing Variables in a Linear Regression: A Graphical Aid," C. L. Mallows, presented at the Central Regional Meeting of the Institute of Mathematical Statistics, Manhattan, Kansas, May 7-9, 1964.

$$C_p = \frac{\text{RESIDUAL SUM OF SQUARES}}{\text{RESIDUAL MEAN SQUARE}} - N + 2p \quad .$$

A C_p -statistic is calculated for each equation. Note that for every variable dropped, the C_p -statistic can decrease by at most 2 units. For the derivation of C_p see [1] and [3].

PRECISION OF X(I)

This statistic is a new statistic not now in the statistical cannon. A paper to be published in the near future by F. S. Wood will introduce it and, hence will not be discussed here.

THE "INTERIOR" or "LOCAL" STATISTICS

All the previous statistics discussed fall under the heading of "global" statistics in that they are statistics of the entire set of data. The "global" statistics are helpful in determining how the independent variables influence the fitted equations, but they do not describe how the observations (the interior of the data) in multifactor space affect the fit. Four innovative "interior" statistics which have been developed (see [1]) can assist in such things as detecting outliers; indicating observations which may influence the form of the equation (possibly introducing curvature); detecting those observations which have the largest effect on the assumed equation, finding those observations which are taken approximately under the same x_i -conditions (called nearby neighbors) and in testing the validity of the "global" statistics. These nearby neighbors are used to obtain a less biased estimate of our error of prediction, $\sigma^2(y)$. The interior statistics defined are weighted by the b_i - values so as to reduce the effects of uninfluential factors.

WSS DISTANCE (Weighted Squared Standardized Distance)

An observation whose points are at the extreme ends of the independent variables are usually far from the "centroid" of all the observations of the data. For instance, a piece of equipment may have a much larger (or smaller) weight than all the rest of the data. A statistic called the Weighted Squared Standardized Distance (WSS DISTANCE), defined by

$$\text{WSS DISTANCE} = \frac{\sum_{i=1}^K \frac{b_i (x_{ij} - \bar{x}_i)^2}{s(y)}}{s(y)},$$

is useful in detecting those observations which are far from the centroid of all the observations. These observations (with large WSS DISTANCE) may indicate that outliers are present or possibly that curvature is needed in the equation.

COMPONENT EFFECTS, C_{ij}

The statistic C_{ij} , where

$$C_{ij} = b_i (x_{ij} - \bar{x}_i),$$

may be defined as the component effects of x_i (the i th independent variable) on y_j (the fitted value of observation j). A nice tabular arrangement (See "COMPONENTS EFFECTS" TABLE) of the components effects assists the analyst in determining the influence that each particular observation has on the fitted equation. This is helpful in the analysis of trade studies.

WSSD

In some cases the observations may have nearly the same x_i - values (for instance similar pieces of equipment) and can be considered as being "close" to each other in multidimensional factor space (nearby neighbors). The statistic

$$\text{WSSD}_{jj'} = \frac{\sum_{i=1}^K \frac{b_i (x_{ij} - x_{ij'})^2}{s(y)}}{s^2(y)} = \frac{1}{s^2(y)} \sum_{i=1}^K (C_{ij} - C_{ij'})^2$$

measures the (squared) distance in "effect space" between two observations j and j' .

This statistic is also helpful in detection of what is known as "Nested Data." If the analyst determines that his data is nested, additional things must be considered to find the correct form of the equations (See [1]).

CUMULATIVE STANDARD DEVIATION ESTIMATED FROM NEAR NEIGHBORS

Recall that as a "global" estimate of random error of prediction, the residual mean square (variance) or the residual root mean square (standard deviation) was used. Sometimes the inner characteristics of the data may indicate that these are not very good estimates. The statistic WSSD identifies those near neighbors which are used to obtain a less biased running estimate, S_n , of $S(y)$ called the standard deviation estimated from near neighbors where

$$S_n = \frac{.886 \left(\sum_n \Delta_n d \right)}{n} .$$

Here $\Delta_n d$ is the absolute value of the differences of the residuals of the neighboring observations, and the value $.886 = 1/1.128$ is used since the expected value of the range for pairs of independent observations from a normal distribution is 1.128. If the residual root mean square is close to the successive estimates of cumulative standard deviation S_n , there is then no evidence of lack of fit of the proposed equation.

STATISTICAL PRINTOUTS AND TABLES

The statistics are printed out in an orderly manner which the analyst can use to further evaluate the fit of an equation. A partial print-out of the statistics on the equation obtained for the fit of the dependent variable MAINTENANCE MANHOURS PER OPERATING HOUR, where $Y_1 = \text{MMH/OH}$, is shown in Figures 1 to 4. Figure 1 shows many of the global statistics, including the coefficients b_i , $S(b_i)$, t_i and the relative influence of x_i for each independent variable x_i . In addition R_y^2 , the F-VALUE and the residual root mean square are displayed.

OBSERVATIONS ORDERED BY COMPUTER INPUT AND BY RESIDUALS

As shown in Figure 2, under the heading "ORDERED BY COMPUTER INPUT," the residuals are listed in the order in which the observations were given to the computer. The Work Unit Code (WUC) of each piece of

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

QAM MODEL RUN 1 DEP VAR 11 Y1 MIN Y = 8.3360-E4 MAX Y = 4.5630-E1 RANGE Y = 4.5540-E1

MULTIPLE REGRESSION ANALYSIS FOR THE "ALPO3" MODEL

$$Y1 = 8(2) + 8(1)X5 + 8(2)X6 + 8(3)X7 + 8(4)X13 + 8(5)X18 + 8(6)X21M$$

$$+ 8(7)X18M + 8(8)X14M + 8(9)X15M + 8(10)X16M + 8(11)X21M$$

$$+ 8(12)X00S2 + 1(13)X10S0 + 8(14)X10S0 + 8(15)X10S0$$

$$+ 8(16)X10S0 + 8(17)X20S0 + 8(18)X18 + 8(19)X18$$

$$Y1 = MMH/DM (MAINTENANCE MANHOURS PER OPERATING HOUR)$$

INDO.VAR(1)	NAME	COEF. R(1)	S.E. COEF.	T-VALUE	R(1)SD	MIN X(1)	MAX X(1)	RANGE X(1)	REL.INF.X(1)
1	X5	-1.95115D-01	2.320-E2	1.9	8.2678	-2.1340-E1	5.3260-E1	7.4600-E1	8.87
2	X6	-7.72745D-02	2.600-E2	2.9	8.4118	-2.3170-E1	5.7630-E1	8.080-E1	8.14
3	X7	-6.49260D-02	2.530-E2	2.6	8.3298	-2.8370-E1	6.6930-E1	9.520-E1	8.12
4	X13	-1.62282D-03	3.510-E4	4.6	8.7229	8.8	1.8620-E2	1.8620-E2	8.35
5	X18	-1.34655D-04	1.400-E4	2.4	8.5777	8.8	1.8620-E2	1.8620-E2	8.87
6	X21M	-6.61367D-05	1.220-E5	5.4	8.8634	-1.4880-E3	6.7620-E3	8.1280-E3	1.19
7	X18M	4.82210D-03	6.510-E4	7.8	8.8672	-3.3360-E1	1.7620-E2	1.7620-E2	1.75
8	X14M	1.87286D-03	3.470-E4	5.4	8.8117	-6.4280-E1	1.7620-E2	1.7620-E2	6.41
9	X15M	1.52358D-03	3.470-E4	4.3	8.9817	-1.6280-E1	8.4670-E1	1.8380-E2	8.26
10	X16M	1.24765D-03	5.370-E4	2.3	8.7482	-3.4330-E0	5.9170-E1	1.8720-E2	8.34
11	X00S0	1.20418D-05	5.300-E6	2.3	8.8333	-4.6300-E0	5.9170-E1	6.1680-E2	8.17
12	X10S0	-1.20418D-05	5.210-E6	2.5	8.8165	6.1610-E4	2.3380-E7	2.3380-E7	8.89
13	X10S0	-3.35510D-05	6.140-E6	5.4	8.8362	1.6400-E0	1.1850-E4	1.1850-E4	8.34
14	X10S0	3.35510D-05	7.930-E6	4.5	8.4764	4.6920-E2	2.5610-E3	2.5610-E3	8.19
15	X10S0	-6.38670D-05	3.910-E5	2.1	8.4329	1.7580-E3	2.8730-E3	2.8730-E3	8.22
16	X20S0	5.78180D-05	2.760-E5	2.1	8.4833	6.2880-E1	1.1610-E3	1.1610-E3	8.14
17	LN49	7.47607D-02	1.830-E2	4.1	8.8689	3.4810-E0	9.8120-E0	5.6110-E0	8.92
18	LN49	-4.98197D-02	1.970-E2	2.5	8.8672	1.8230-E1	5.1570-E0	4.9750-E0	8.54

NO. OF OBSERVATIONS 63
 NO. OF INDO. VARIABLES 19
 RESIDUAL DEGREES OF FREEDOM 43
 F-VALUE 28.5
 RESIDUAL ROOT MEAN SQUARE 8.63915483
 RESIDUAL MEAN SQUARE 8.68896927
 RESIDUAL SUM OF SQUARES 8.63908842
 TOTAL SUM OF SQUARES 8.39288338
 MULT. CORREL. COEF. SQUARED .9885

REQUIRED X(1) PRECISION
 (DIGIT RIGHT OF DECIMAL POSITIVE,
 LEFT OF DECIMAL NEGATIVE)

INDO.VAR(1)	DIGIT
1	1
2	1
3	1
4	-2
5	-2
6	-3
7	-2
8	-2
9	-2
10	-2
11	-2
12	-2
13	-4
14	-4
15	-4
16	-3
17	-3
18	1
19	1

FIGURE 1

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

QW MODEL	RUN 1	DEP VAR 11	Y1	ORDERED BY COMPUTER INPUT				ORDERED BY RESIDUALS				SEC
IDENT.	OBSV.	MS3 DISTANCE	OBS. Y	FITTED Y	RESIDUAL	OBSV.	OBS. Y	FITTED Y	ORDERED RESID.	SEC		
7182A	1	19.	0.834	0.831	-0.003	81	0.168	0.167	0.001	1		
7182B	2	8.	0.831	0.826	-0.005	4	0.266	0.266	0.000	2		
7182C	3	8.	0.831	0.826	-0.005	32	0.266	0.266	0.000	3		
7182D	4	23.	0.828	0.823	-0.005	27	0.264	0.264	0.000	4		
7182E	5	9.	0.824	0.819	-0.005	7	0.263	0.263	0.000	5		
7182F	6	7.	0.825	0.820	-0.005	59	0.143	0.143	0.000	6		
7182G	7	82.	0.826	0.821	-0.005	17	0.211	0.211	0.000	7		
7182H	8	86.	0.822	0.817	-0.005	22	0.456	0.456	0.000	8		
7182I	9	50.	0.822	0.817	-0.005	40	0.088	0.088	0.000	9		
7182J	10	53.	0.822	0.817	-0.005	24	0.077	0.077	0.000	10		
7182K	11	53.	0.822	0.817	-0.005	31	0.095	0.095	0.000	11		
7182L	12	53.	0.822	0.817	-0.005	11	0.019	0.019	0.000	12		
7182M	13	42.	0.822	0.817	-0.005	03	0.075	0.075	0.000	13		
7182N	14	34.	0.822	0.817	-0.005	07	0.122	0.122	0.000	14		
7182O	15	23.	0.822	0.817	-0.005	28	0.084	0.084	0.000	15		
7182P	16	91.	0.822	0.817	-0.005	58	0.190	0.190	0.000	16		
7182Q	17	91.	0.822	0.817	-0.005	33	0.105	0.105	0.000	17		
7182R	18	142.	0.822	0.817	-0.005	53	0.031	0.031	0.000	18		
7182S	19	63.	0.822	0.817	-0.005	8	0.082	0.082	0.000	19		
7182T	20	527.	0.822	0.817	-0.005	5	0.021	0.021	0.000	20		
7182U	21	64.	0.822	0.817	-0.005	51	0.081	0.081	0.000	21		
7182V	22	75.	0.822	0.817	-0.005	52	0.044	0.044	0.000	22		
7182W	23	30.	0.822	0.817	-0.005	42	0.086	0.086	0.000	23		
7182X	24	27.	0.822	0.817	-0.005	66	0.030	0.030	0.000	24		
7182Y	25	29.	0.822	0.817	-0.005	35	0.095	0.095	0.000	25		
7182Z	26	64.	0.822	0.817	-0.005	28	0.017	0.017	0.000	26		
7183A	27	64.	0.822	0.817	-0.005	48	0.083	0.083	0.000	27		
7183B	28	64.	0.822	0.817	-0.005	1	0.037	0.037	0.000	28		
7183C	29	60.	0.822	0.817	-0.005	64	0.054	0.054	0.000	29		
7183D	30	17.	0.822	0.817	-0.005	46	0.059	0.059	0.000	30		
7183E	31	16.	0.822	0.817	-0.005	13	0.065	0.065	0.000	31		
7183F	32	36.	0.822	0.817	-0.005	02	0.052	0.052	0.000	32		
7183G	33	44.	0.822	0.817	-0.005	41	0.065	0.065	0.000	33		
7183H	34	35.	0.822	0.817	-0.005	38	0.026	0.026	0.000	34		
7183I	35	39.	0.822	0.817	-0.005	06	0.049	0.049	0.000	35		
7183J	36	43.	0.822	0.817	-0.005	45	0.048	0.048	0.000	36		
7183K	37	43.	0.822	0.817	-0.005	34	0.067	0.067	0.000	37		
7183L	38	41.	0.822	0.817	-0.005	54	0.093	0.093	0.000	38		
7183M	39	42.	0.822	0.817	-0.005	47	0.237	0.237	0.000	39		
7183N	40	42.	0.822	0.817	-0.005	36	0.034	0.034	0.000	40		
7183O	41	43.	0.822	0.817	-0.005	16	0.071	0.071	0.000	41		
7183P	42	43.	0.822	0.817	-0.005	37	0.101	0.101	0.000	42		
7183Q	43	45.	0.822	0.817	-0.005	57	0.105	0.105	0.000	43		
7183R	44	65.	0.822	0.817	-0.005	25	0.080	0.080	0.000	44		
7183S	45	65.	0.822	0.817	-0.005	43	0.084	0.084	0.000	45		
7183T	46	210.	0.822	0.817	-0.005	15	0.011	0.011	0.000	46		
7183U	47	16.	0.822	0.817	-0.005	49	0.174	0.174	0.000	47		
7183V	48	16.	0.822	0.817	-0.005	59	0.028	0.028	0.000	48		
7183W	49	76.	0.822	0.817	-0.005	19	0.062	0.062	0.000	49		
7183X	50	76.	0.822	0.817	-0.005	8	0.174	0.174	0.000	50		
7183Y	51	76.	0.822	0.817	-0.005	29	0.031	0.031	0.000	51		
7183Z	52	76.	0.822	0.817	-0.005	18	0.168	0.168	0.000	52		
7184A	53	42.	0.822	0.817	-0.005	26	0.015	0.015	0.000	53		
7184B	54	42.	0.822	0.817	-0.005	5	0.049	0.049	0.000	54		
7184C	55	42.	0.822	0.817	-0.005	21	0.085	0.085	0.000	55		
7184D	56	56.	0.822	0.817	-0.005	30	0.031	0.031	0.000	56		
7184E	57	7.	0.822	0.817	-0.005	98	0.046	0.046	0.000	57		
7184F	58	6.	0.822	0.817	-0.005	18	0.176	0.176	0.000	58		
7184G	59	25.	0.822	0.817	-0.005	6	0.026	0.026	0.000	59		
7184H	60	19.	0.822	0.817	-0.005	2	0.031	0.031	0.000	60		
7184I	61	19.	0.822	0.817	-0.005	3	0.061	0.061	0.000	61		
7184J	62	28.	0.822	0.817	-0.005	6	0.026	0.026	0.000	62		
7184K	63	27.	0.822	0.817	-0.005	3	0.031	0.031	0.000	63		
7184L	64	19.	0.822	0.817	-0.005	35	0.051	0.051	0.000	64		
7184M	65	8.	0.822	0.817	-0.005	68	0.037	0.037	0.000	65		
7184N	66	19.	0.822	0.817	-0.005	68	0.082	0.082	0.000	66		
7184O	67	40.	0.822	0.817	-0.005	68	0.025	0.025	0.000	67		
7184P	68	40.	0.822	0.817	-0.005	68	0.065	0.065	0.000	68		

FIGURE 2

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM									
QRM MODEL	RUN 1	DEP VAR 11	Y1	RESIDUAL ROOT MEAN SQUARE OF FITTED EQUATION1				9.93	
STANDARD DEVIATION ESTIMATED FROM RESIDUALS OF NEIGHBORING OBSERVATIONS (OBSERVATIONS 1 TO 4 PART IN FITTED Y ORDER).									
NO.	CUMULATIVE STO DEV	ORDERED BY MSSD OBSV.	DEL RESIDUALS	MSSD DEL RESIDUALS	ORDERED BY FITTED Y RESIDUALS	FITTED Y	OBSV.	SEQ.	
1.	0.00	27	0.00	0.00	1	-0.03	7	1	
2	0.00	37	0.00	0.00	2	-0.02	40	2	
3	0.00	57	0.00	0.00	3	-0.02	12	3	
4	0.00	53	0.00	0.00	4	-0.01	20	4	
5	0.00	7	0.00	0.00	5	-0.01	53	5	
6	0.00	18	0.00	0.00	6	-0.01	51	6	
7	0.00	44	0.00	0.00	7	-0.01	4	7	
8	0.00	32	0.00	0.00	8	-0.01	11	8	
9	0.00	35	0.00	0.00	9	-0.01	54	9	
10	0.00	36	0.00	0.00	10	-0.01	55	10	
11	0.00	56	0.00	0.00	11	-0.02	36	11	
12	0.00	58	0.00	0.00	12	-0.02	52	12	
13	0.00	43	0.00	0.00	13	-0.02	43	13	
14	0.00	25	0.00	0.00	14	-0.02	25	14	
15	0.00	59	0.00	0.00	15	-0.02	9	15	
16	0.00	3	0.00	0.00	16	-0.02	60	16	
17	0.00	3	0.00	0.00	17	-0.03	15	17	
18	0.00	66	0.00	0.00	18	-0.03	15	18	
19	0.00	4	0.00	0.00	19	-0.03	30	19	
20	0.00	3	0.00	0.00	20	-0.03	44	20	
21	0.00	61	0.00	0.00	21	-0.03	1	21	
22	0.00	54	0.00	0.00	22	-0.03	39	22	
23	0.00	61	0.00	0.00	23	-0.03	21	23	
24	0.00	54	0.00	0.00	24	-0.03	32	24	
25	0.00	25	0.00	0.00	25	-0.04	19	25	
26	0.00	1	0.00	0.00	26	-0.04	18	26	
27	0.00	7	0.00	0.00	27	-0.04	42	27	
28	0.00	1	0.00	0.00	28	-0.05	20	28	
29	0.00	58	0.00	0.00	29	-0.05	45	29	
30	0.00	67	0.00	0.00	30	-0.05	45	30	
31	0.00	66	0.00	0.00	31	-0.05	64	31	
32	0.00	7	0.00	0.00	32	-0.05	62	32	
33	0.00	36	0.00	0.00	33	-0.06	24	33	
34	0.00	17	0.00	0.00	34	-0.06	63	34	
35	0.00	35	0.00	0.00	35	-0.06	6	35	
36	0.00	7	0.00	0.00	36	-0.07	13	36	
37	0.00	69	0.00	0.00	37	-0.07	20	37	
38	0.00	61	0.00	0.00	38	-0.07	41	38	
39	0.00	64	0.00	0.00	39	-0.07	34	39	
40	0.00	2	0.00	0.00	40	-0.07	34	40	
41	0.00	19	0.00	0.00	41	-0.07	5	41	
42	0.00	13	0.00	0.00	42	-0.07	50	42	
43	0.00	15	0.00	0.00	43	-0.08	48	43	
44	0.00	13	0.00	0.00	44	-0.08	48	44	
45	0.00	58	0.00	0.00	45	-0.09	35	45	
46	0.00	2	0.00	0.00	46	-0.09	66	46	
47	0.00	57	0.00	0.00	47	-0.09	33	47	
48	0.00	50	0.00	0.00	48	-0.10	58	48	
49	0.00	6	0.00	0.00	49	-0.10	3	49	
50	0.00	9	0.00	0.00	50	-0.11	57	50	
51	0.00	36	0.00	0.00	51	-0.11	56	51	
52	0.00	57	0.00	0.00	52	-0.11	67	52	
53	0.00	60	0.00	0.00	53	-0.11	61	53	
54	0.00	56	0.00	0.00	54	-0.11	60	54	
55	0.00	61	0.00	0.00	55	-0.18	17	55	
56	0.00	41	0.00	0.00	56	-0.18	37	56	
57	0.00	17	0.00	0.00	57	-0.18	27	57	
58	0.00	7	0.00	0.00	58	-0.19	20	58	
59	0.00	61	0.00	0.00	59	-0.19	31	59	
60	0.00	17	0.00	0.00	60	-0.19	40	60	
61	0.00	40	0.00	0.00	61	-0.21	10	61	
62	0.00	37	0.00	0.00	62	-0.24	47	62	
63	0.00	31	0.00	0.00	63	-0.24	68	63	

FIGURE 3

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

Q&M MODEL RUN 1 DEP VAR 11 Y1

COMPONENT EFFECT OF EACH VARIABLE ON EACH OBSERVATION (IN UNITS OF Y)
(VARIABLES ORDERED BY THEIR RELATIVE INFLUENCE --- OBSERVATIONS ORDERED BY INFLUENCE OF MOST INFLUENTIAL VARIABLE)

VARIABLES		17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
SEQ.	OBS.	X17M	X18M	X19M	X20M	X21M	X22M	X23M	X24M	X25M	X26M	X27M	X28M	X29M	X30M	X31M	X32M	X33M	X34M	X35M	X36M	X37M	X38M	X39M	X40M	X41M	X42M	X43M	X44M	X45M	X46M	X47M
1	47	0.04	0.26	0.14	0.03	0.10	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
2	22	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
3	49	0.08	0.45	0.17	0.30	0.28	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
4	18	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
5	28	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
6	42	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
7	31	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
8	29	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
9	17	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
10	27	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
11	37	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
12	24	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
13	60	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
14	61	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
15	63	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
16	67	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
17	50	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
18	41	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
19	46	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
20	66	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
21	3	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
22	5	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
23	34	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
24	2	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
25	6	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
26	56	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
27	57	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
28	48	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

FIGURE 4

29	33	-0.01	0.01	0.03	-0.03	-0.02	-0.06	0.00	0.01	-0.01	-0.02	0.01	-0.04	-0.01	-0.08
30	35	-0.02	-0.02	-0.05	-0.04	-0.02	0.07	-0.01	0.01	-0.01	-0.02	0.00	-0.03	-0.00	-0.02
31	4	-0.01	-0.02	0.01	-0.06	-0.02	-0.07	-0.01	0.01	-0.01	0.07	-0.04	0.03	-0.01	-0.00
32	13	-0.03	-0.00	-0.00	-0.00	0.01	0.02	-0.01	0.01	-0.01	-0.02	0.01	0.03	0.02	-0.00
33	58	-0.03	-0.03	-0.03	-0.03	-0.01	0.02	-0.01	0.01	-0.01	-0.02	0.01	0.03	-0.01	-0.00
34	02	-0.03	0.01	-0.07	-0.07	-0.01	0.02	-0.01	0.01	0.01	-0.02	0.00	0.03	0.00	0.00
35	64	-0.03	0.01	-0.07	-0.07	-0.01	0.02	-0.01	0.01	0.01	-0.02	0.00	0.03	0.00	0.00
36	52	-0.04	0.01	-0.03	-0.03	-0.01	0.07	-0.01	0.01	-0.01	-0.02	0.01	-0.04	-0.01	-0.00
37	45	-0.05	0.06	-0.03	-0.03	-0.01	-0.12	0.15	0.00	-0.01	-0.02	0.01	-0.03	-0.01	-0.00
38	1	-0.00	-0.00	-0.00	-0.00	-0.01	0.04	-0.01	-0.00	-0.01	-0.02	-0.03	0.01	-0.01	-0.00
39	44	-0.00	-0.00	-0.00	-0.00	-0.01	0.07	-0.01	-0.01	-0.01	-0.02	0.01	-0.04	0.00	-0.00
40	9	-0.01	-0.00	-0.00	-0.00	-0.01	0.05	-0.01	-0.01	-0.01	-0.02	-0.03	-0.00	0.01	-0.00
41	36	-0.03	-0.03	-0.03	-0.03	-0.01	-0.12	-0.01	-0.01	0.15	-0.02	0.01	-0.03	-0.01	-0.00
42	59	-0.00	-0.00	-0.00	-0.00	-0.01	0.02	-0.01	-0.01	-0.01	-0.02	0.01	0.03	-0.01	-0.00
43	10	-0.00	-0.00	-0.00	-0.00	-0.01	-0.03	0.07	-0.01	-0.01	-0.02	0.00	0.05	0.02	-0.00
44	11	-0.03	-0.03	-0.03	-0.03	-0.01	-0.06	-0.01	-0.01	-0.01	-0.02	0.06	-0.03	-0.01	-0.00
45	32	-0.00	-0.00	-0.00	-0.00	-0.01	0.07	-0.01	-0.01	-0.01	-0.02	0.00	-0.03	-0.01	-0.00
46	55	-0.00	-0.00	-0.00	-0.00	-0.01	-0.12	-0.01	-0.01	-0.01	-0.02	0.10	-0.03	-0.01	-0.00
47	26	-0.00	-0.00	-0.00	-0.00	-0.01	0.07	-0.01	-0.01	-0.01	-0.02	0.01	-0.04	-0.01	-0.00
48	43	-0.01	-0.01	-0.01	-0.01	-0.01	-0.12	-0.01	-0.01	-0.01	-0.02	0.10	-0.03	-0.01	-0.00
49	21	-0.01	-0.01	-0.01	-0.01	-0.01	-0.12	-0.01	-0.01	-0.01	-0.02	0.10	-0.03	-0.01	-0.00
50	39	-0.00	-0.00	-0.00	-0.00	-0.01	-0.06	-0.01	-0.02	-0.01	-0.02	0.06	-0.03	-0.01	-0.00
51	68	-0.00	-0.00	-0.00	-0.00	-0.01	-0.05	0.00	-0.02	-0.01	-0.02	0.01	0.05	-0.01	-0.00
52	51	-0.00	-0.00	-0.00	-0.00	-0.01	-0.12	-0.01	-0.02	-0.01	-0.02	0.01	-0.03	-0.01	-0.00
53	53	-0.00	-0.00	-0.00	-0.00	-0.01	-0.12	-0.01	-0.02	-0.01	-0.02	0.01	-0.03	-0.01	-0.00
54	54	-0.00	-0.00	-0.00	-0.00	-0.01	-0.07	-0.01	-0.02	-0.01	-0.02	0.01	-0.03	-0.01	-0.00
55	15	-0.00	-0.00	-0.00	-0.00	-0.01	0.06	-0.01	-0.02	-0.01	-0.02	0.01	-0.03	-0.01	-0.00
56	36	-0.00	-0.00	-0.00	-0.00	-0.01	0.07	-0.01	-0.02	-0.01	-0.02	0.01	-0.03	-0.01	-0.00
57	12	-0.00	-0.00	-0.00	-0.00	-0.01	0.07	-0.01	-0.02	-0.01	-0.02	0.01	-0.03	-0.01	-0.00
58	7	-0.00	-0.00	-0.00	-0.00	-0.01	0.07	-0.01	-0.02	-0.01	-0.02	0.01	-0.03	-0.01	-0.00
59	46	-0.00	-0.00	-0.00	-0.00	-0.01	0.07	-0.01	-0.02	-0.01	-0.02	0.01	-0.03	-0.01	-0.00
60	25	-0.00	-0.00	-0.00	-0.00	-0.01	0.07	-0.01	-0.02	-0.01	-0.02	0.01	-0.03	-0.01	-0.00
61	19	-0.00	-0.00	-0.00	-0.00	-0.01	0.07	-0.01	-0.02	-0.01	-0.02	0.01	-0.03	-0.01	-0.00
62	8	-0.00	-0.00	-0.00	-0.00	-0.01	0.07	-0.01	-0.02	-0.01	-0.02	0.01	-0.03	-0.01	-0.00
63	28	-0.00	-0.00	-0.00	-0.00	-0.01	0.07	-0.01	-0.02	-0.01	-0.02	0.01	-0.03	-0.01	-0.00

FIGURE 4 (CONT.)

equipment is given in the first column for identification purposes. The third column shows the WSS DISTANCE for each observation. Here those observations far from the centroid of all observations can be easily spotted (observation 47 and 22). Under the heading "ORDERED BY RESIDUALS," the residuals are listed in the order of the magnitude of the residuals. This gives an indication of which observations are fitted the best (or worst). As can be seen, observations 46 and 13 are fitted best and 61 is fitted worst.

STANDARD DEVIATION ESTIMATED FROM RESIDUALS OF NEIGHBORING OBSERVATIONS

The cumulative estimates, S_n , of the standard deviation are printed in the second column of Figure 3. The $WSSD_{jj}$ of the observations in columns 4 and 5 are printed in the third column. Also the observations are ordered by their increasing fitted y values. At the top of Figure 3 is the residual root mean square = .03. The cumulative standard deviation column indicates that the standard deviation estimated from near neighbors is approximately .03, hence there is no evidence of lack of fit.

"COMPONENT EFFECTS" TABLE

The component effect, C_{ij} , of each variable on each observation is printed in tabular form (Figure 4) where the variables are ordered by their decreasing relative influences in columns, and the observations are ordered by their decreasing effects on the most influential variables in rows. Here the analyst can see which particular observations are most influential in their effects on the fitted equation. In addition this table can be used to determine the importance of high correlation among the independent variables.

STATISTICAL PLOTS

As with any endeavor dealing with Deductive Reasoning, the conclusions are dependent on the validity of the assumptions. Thus the analyst must have some means of verifying the degree to which the assumptions are satisfied. In addition to the number of statistics and statistical tables, there are five types of computerized plots that can be used to determine how close the data and fitted equations satisfy the assumptions. These plots give the analyst much insight

into the fit that the statistics alone cannot. The plots are used to determine (1) whether the assumptions of the method of least-squares are "nearly" satisfied, (2) just how well (or bad) the equation fits the data, and (3) to obtain further insights into the distributional properties of the data and how these properties affect the fit.

CUMULATIVE DISTRIBUTION OF RESIDUALS

When k independent variables are fitted to data with normally distributed error (Assumption A3), it can be shown that the residuals also have a Normal distribution. Therefore, the graph of the residual versus cumulative frequency should be "nearly" a straight line. This plot is helpful in determining whether the data satisfies Assumptions A1, A2 and A4. Figure 5 is a plot for the initial fit of $\ln(\text{MTBF})$. Obviously there is an observation whose residual is separated from the rest of the data. This observation may be an outlier (violating Assumption A1) or may indicate that some form of curvature is needed in the equation (Assumption A2). After investigation it was determined that the point was indeed an outlier. Figure 6 is the cumulative frequency plot for the fitted equation obtained, with $\ln(\text{MTBF})$ as the dependent variable. There is no indication here of deficiencies in the fit.

RESIDUALS VS FITTED Y

The plot of the residuals versus the fitted values of the dependent variable is also helpful in checking Assumption A1, A2 and A4. This plot may show whether there is some dependence of the magnitude of the residuals on the magnitude of the fitted values. Daniel and Wood [1], gives four common defects that may be revealed by such plots. Recall Assumption A3 states that the variance of the error is constant. The plot of residual versus fitted Y should then show an equal scatter about the 0-residual line. Figure 7 is a plot for the initial fit of $\ln(\text{MTBF})$. As in the cumulative frequency plot, (Figure 5) one observation is separated from the remainder of the data. Both the cumulative frequency plot and the plot of residual vs. fitted y are necessary to determine whether a point is an outlier. Again, if this observation is at the extreme ends of the ranges of the dependent variable, curvature may be the solution. Figure 8 is a plot of

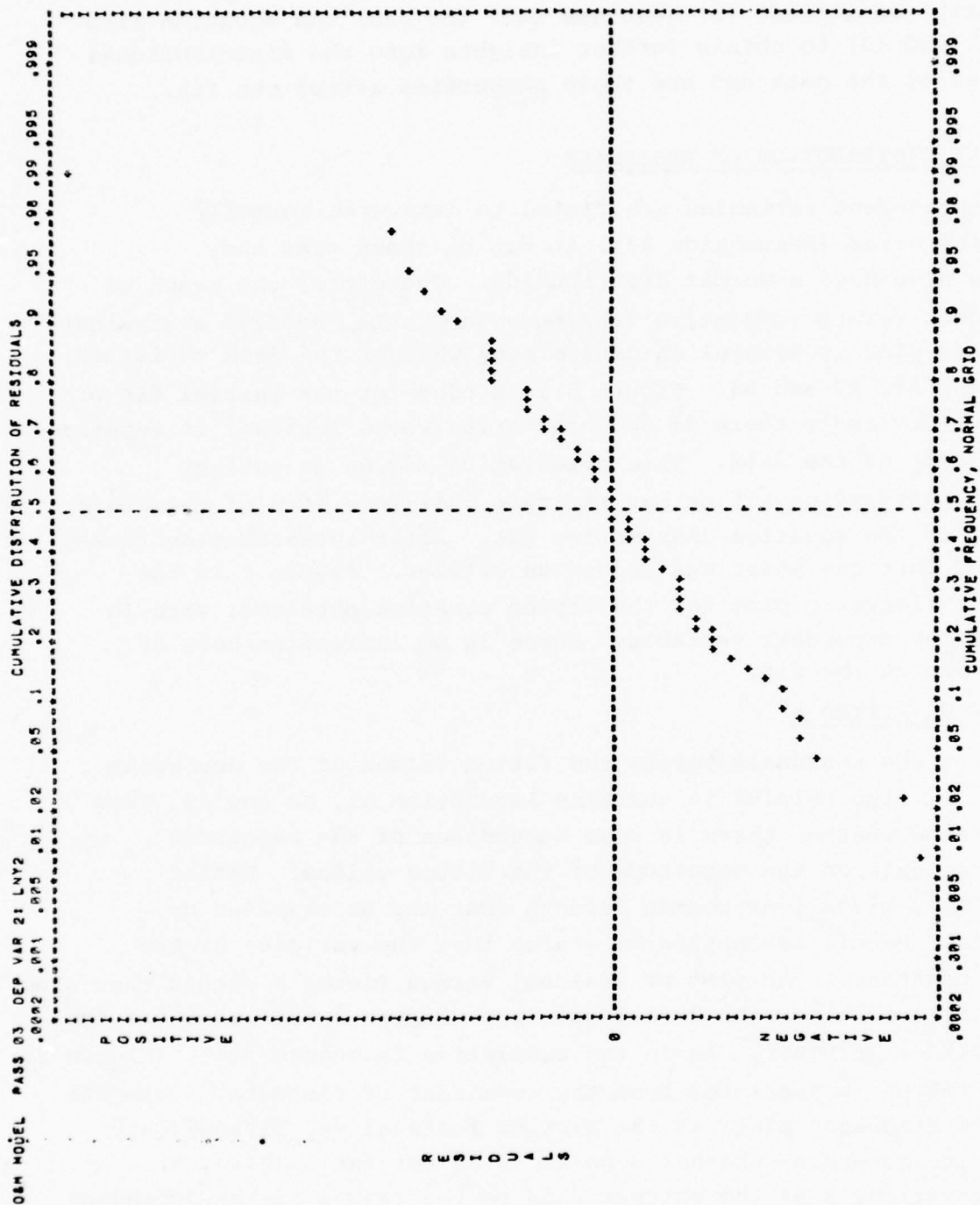


FIGURE 5

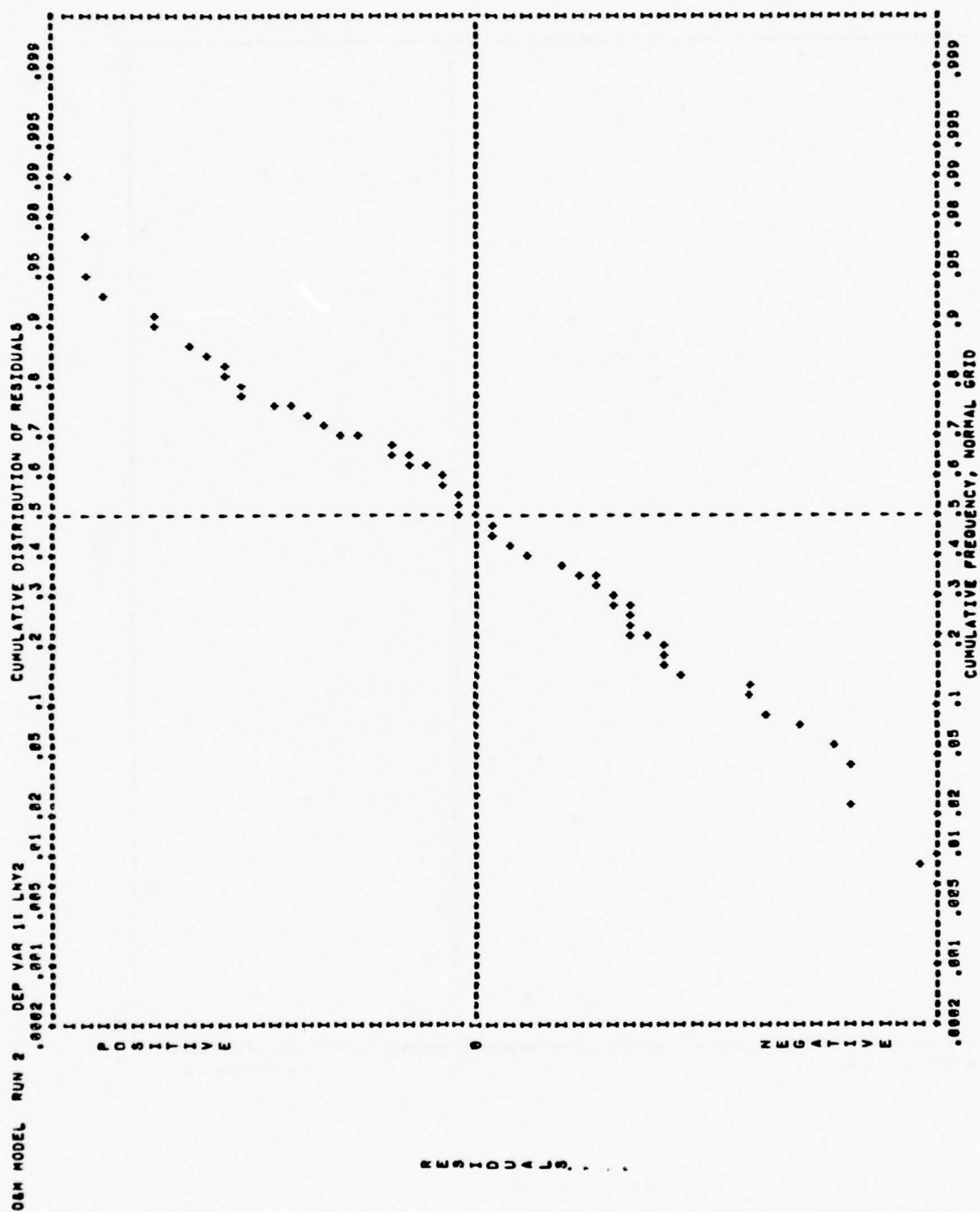


FIGURE 6

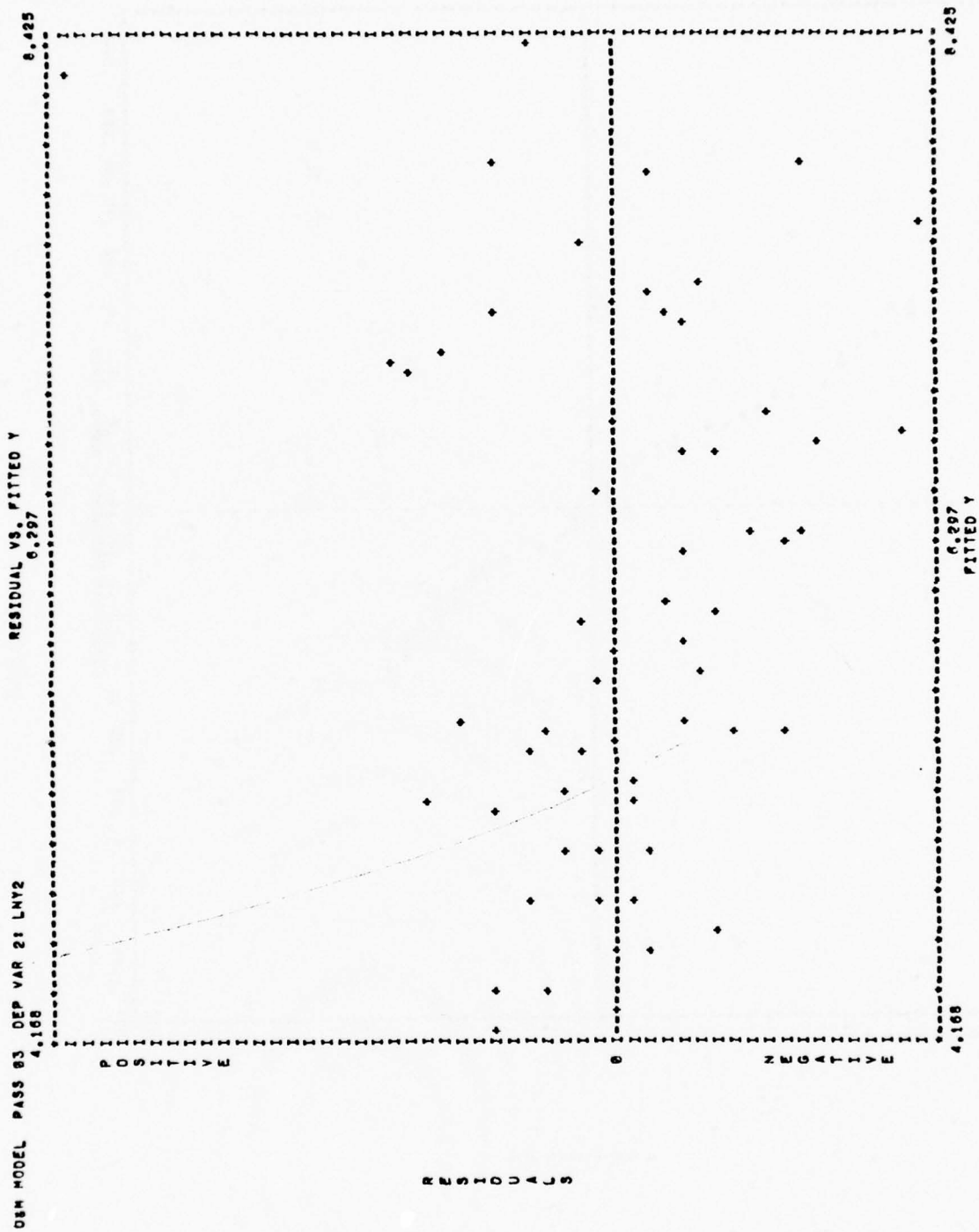


FIGURE 7

residuals versus fitted Y for the equation obtained for $\ln(\text{MTBF})$. The equal scatter of the residuals do not indicate deficiencies in the equation obtained (as was the case in Figure 6).

RESIDUALS VS INDEPENDENT VARIABLE X(I)

The pattern of the residuals in the plot residuals versus independent variable x_1 is useful in determining whether other functional forms of the independent variables are needed. The residuals should be equally scattered about the 0-residual line. As an actual example, Figure 9 is a plot of the residuals versus an independent variable x_1 where obviously a squared term is needed in the equation. This plot was obtained when a fit

$$y = b_0 + b_1x_1 + b_2x_2$$

was made to a set of data when the true form of the equation was

$$y = b_0 + b_1x_1 + b_2x_2 + b_1x_1^2 \quad .$$

For this fit however the "global" statistics were significant and did not indicate anything wrong with the fitted equation. In particular $R_Y^2 = .9047$ and the F-VALUE = 228. Figure 10 is another example plot where the equation

$$y = b_0 + b_1x_1 + b_2x_2^2 + b_3x_1^3$$

was fitted to data and the true form was

$$y = b_0 + b_1x_1 + b_2x_2^2 + b_3x_1^4$$

Here, $R_Y^2 = .9963$ and the F-VALUE = 3267. These two simple examples indicate why the practice of considering only R_Y^2 and the F-VALUE as measures of "goodness of fit" is not statistically sound.

COMPONENT AND COMPONENT-PLUS-RESIDUALS VS INDEPENDENT VARIABLE X(I)

The component versus independent variable x_i is a plot of the component effect C_{ij} of each observation on each variable versus the independent variable. The component-plus-residuals is the sum of the component effects of each observation and its residual. As stated in [1],

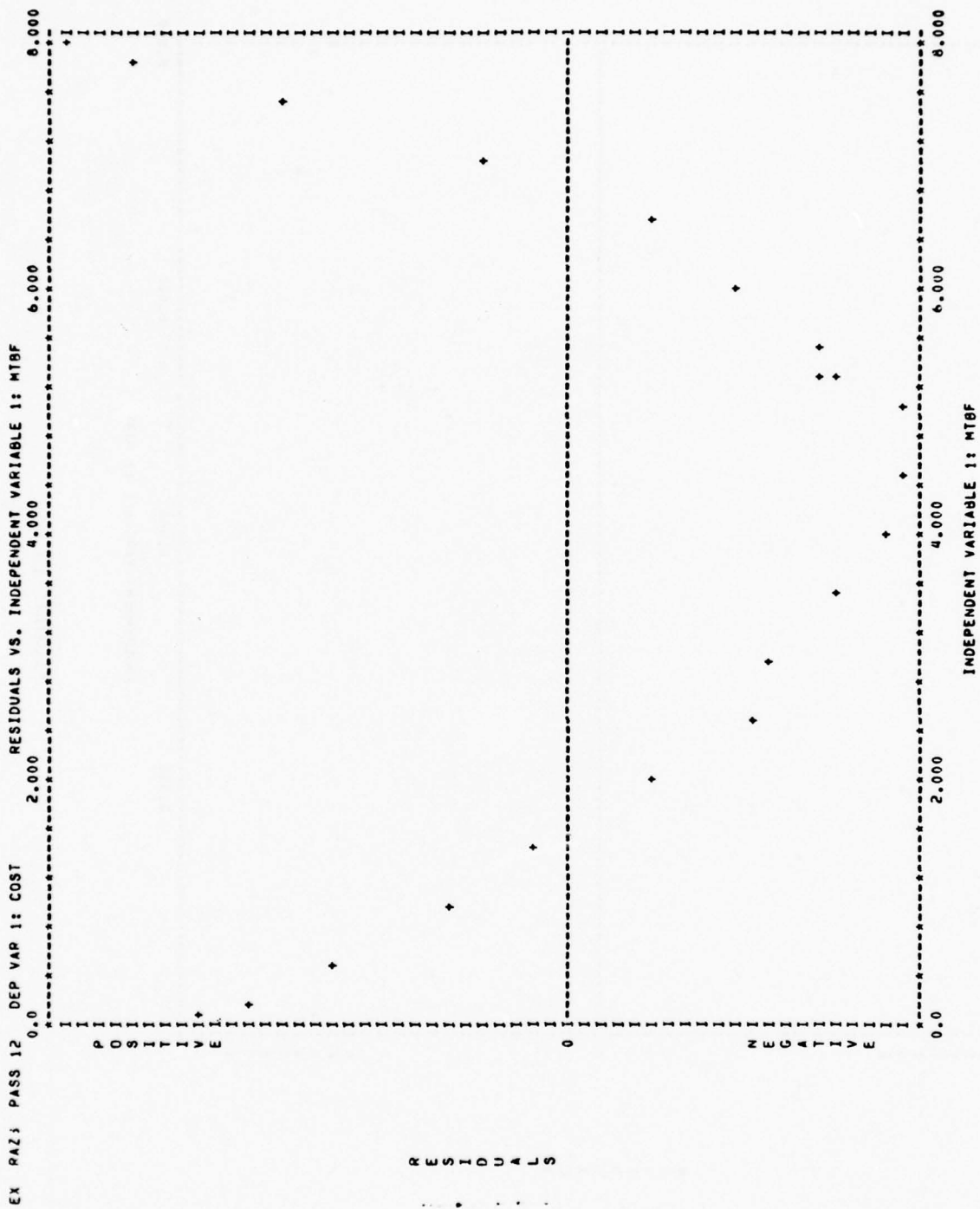


FIGURE 9

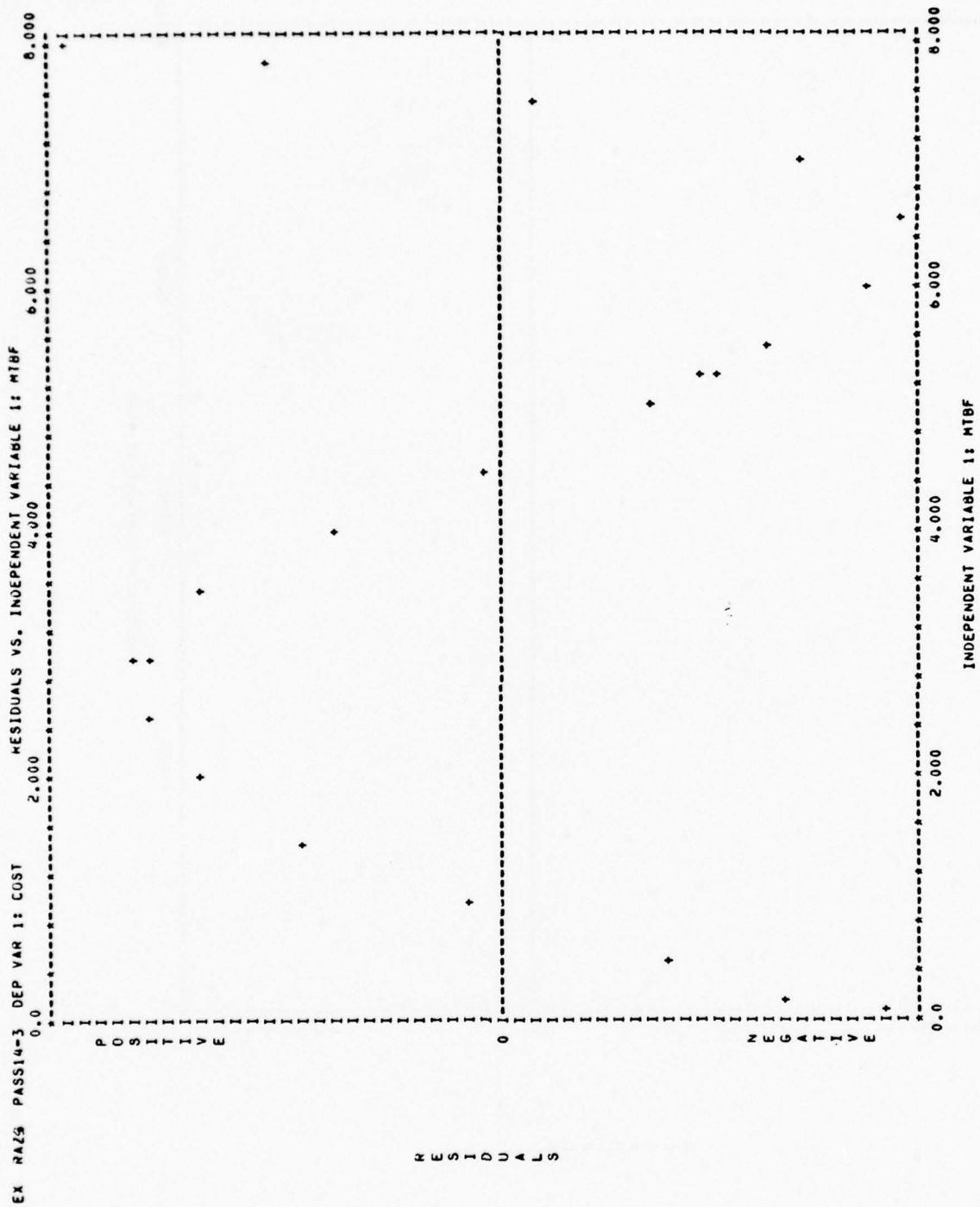


FIGURE 10

"Component-plus residual plots are used as an aid
 (1) to choose the appropriate form of the equation,
 (2) to observe the distribution of the observations
 over the range of each independent variable and
 (3) to estimate the influence of each observation
 on each component of the equation."

Observations at the extreme ends of the ranges of the independent variables usually control the estimates of the statistics. The component-plus-residuals plots can be used (with indicator variables and the C_p -search technique) to determine if these extreme points are compatible with the remainder of the data. If it is determined that these extreme values are not compatible with the rest of the data, then either curvature should be introduced in that independent variable or other subjective information (introduced by indicator variables) about the points in question should be considered.

Figure 11 is a plot for the training cost equation obtained, where the independent variable is the % power supply. As can be seen from the graph, only one observation extends the range of % power supply by over 3,000%. It was later found out that introducing curvature in the % power supply had a significant impact on the fit. The residuals should be equally scattered about the component line.

CP VS P

The C_p -plot (developed by Mallows [3]), is a plot of the C_p -statistic for an equation versus P where $P = k + 1$. For those equations with negligible bias, the C_p -statistic will fall near line $C_p = p$. Obviously the analyst would like to choose the equations with smallest total squared errors (C_p) and with the least amount of bias. Figure 12 is an example of a C_p -plot for the NRTS equation obtained where it can be seen that the C_p -statistic 1 is on the line $C_p = p$ which indicates that there is no evidence of function bias. The C_p -statistic 2 is about the same as 1 but is above the line $C_p = p$ and indicates that more is present in equation 2 than equation 1.

STATISTICAL TECHNIQUES

There are two techniques utilized that are helpful in finding the subset collection of variables which best fits the data and in determining the stability of the equations obtained.

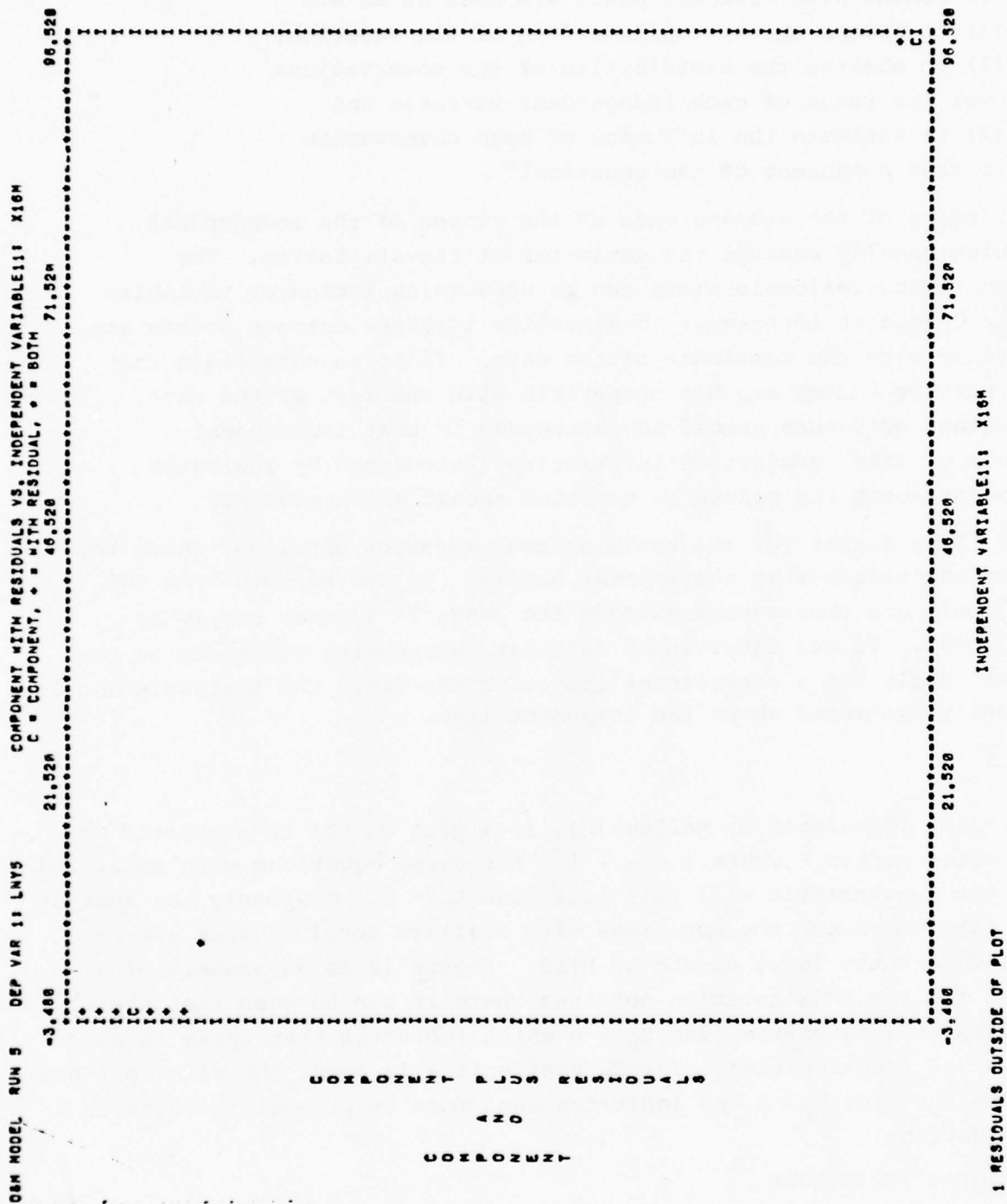


FIGURE 11

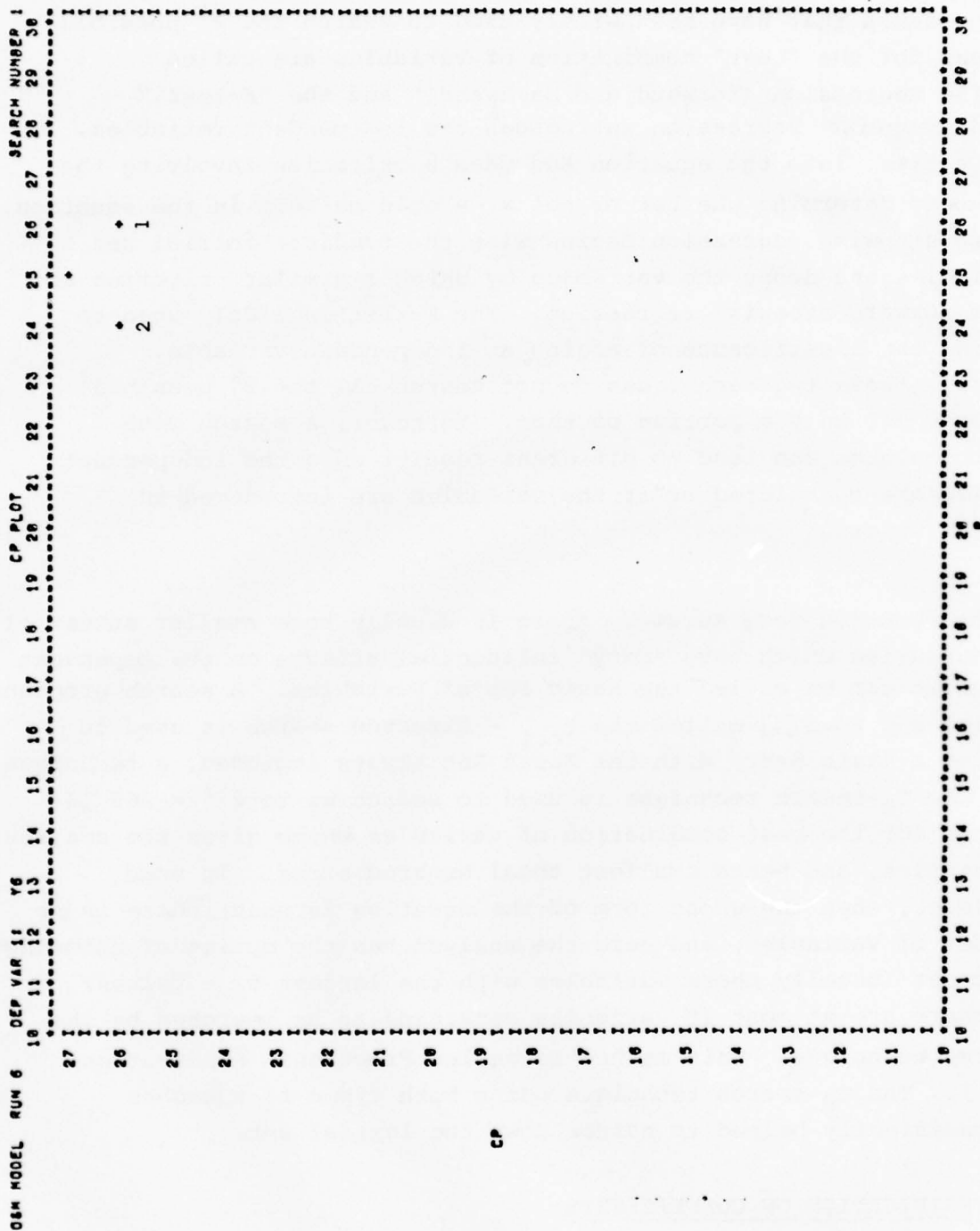


FIGURE 12

CP-SEARCH TECHNIQUE

Two approaches that have been widely used to search the 2^K possible equations for the "best" combination of variables are called "Stepwise Regression (forward and backward)" and the "F-test." Forward stepwise regression introduces the independent variables, one at a time, into the equation and uses a criterion involving the t_i values to determine whether or not x_i should be left in the equation. Backward stepwise regression begins with the complete initial set of variables and drops the variables by using a similar criterion as that of forward stepwise regression. The F-test is widely used to determine the significance of adding an independent variable. Obviously, these two techniques do not search all the 2^K possible equations, but only a portion of them. Moreover, a search with these techniques can lead to different results when the independent variables are correlated or if the variables are introduced in different orders.

With the equation form assumed, there is usually some smaller subset of these variables which have "very" influential effects on the dependent variable. This subset can be called the Basic Set of Variables. A search proposed by Daniel and Wood[1] called the $t_{k,i}$ - directed search is used to determine a Basic Set. With the Basic Set always included, a technique called the C_p -search technique is used to search up to $2^{18} = 262,144$ equations for the best combination of variables which gives the smallest C_p -statistics, and hence smallest total squared error. In some cases (e.g., when the wrong form of the equation is used) there is no Basic Set of Variables, and here the analyst has the option of choosing a basic set (usually those variables with the largest t_i - values) until there are at most 18 variables remaining to be searched by the C_p -search technique. This method is called Fractional Replication (See [2]). The C_p -search technique using both types of searches have consistently helped to narrow down the initial set.

CROSS VERIFICATION OF COEFFICIENTS

Once a presumably final equation is obtained, the analyst must determine the stability of the obtained equations coefficients. There

may be a few observations in the data base (such as those with large WSS DISTANCE and large residuals) that are not compatible with the rest of the data and may be controlling the estimates of the fitted coefficients. A way to determine stability is to drop those observations, run another regression and determine the effects on the least-squares estimates of the coefficients. This technique is called cross verification of coefficients with a second sample of data and provides a rigorous test of the data, the model and the fitted coefficients.

Component-plus-residual plots of the second sample of data (where residuals are calculated using the initial coefficients) may point out those observations which may indicate that other forms of curvature are needed.

SECTION VI

AN EXAMPLE,

MEAN TIME BETWEEN MAINTENANCE ACTIONS (MTBMA)

The data (a year's worth of data) was chosen from existing data systems to determine the CER's and PER's used to estimate O&M cost and is shown in Appendix A. There are 64 pieces of avionics equipment (observations), called LRU's, on which the study is based. Each observation can be identified by its observation number and Work Unit Code (WUC). Also associated with each is a total of 27 variables, of which 21 are independent variables and 6 are dependent variables. The independent variables are of two types, quantitative and qualitative. The usual types of variables in a regression exercise are quantitative (i.e., variables that may take on values over a given range) such as weight or other physical characteristics of the equipment. Many times additional (qualitative) information is available, such as certain characteristics of the equipment or a certain class in which the equipment belongs, which should not be discarded, but should be introduced into the regression, since more information should lead to a better fit. "Indicator" variables (variables which take on the value of 0 or 1) are used to introduce qualitative information into the regressions. A "1" indicates that the observation is in a certain class and a "0" indicates that it is not.

The type of aircraft in which a piece of equipment is used and the equipment avionics areas are the two qualitative classes used in

this study. There are three types of aircraft: Fighters, Bombers and Cargo and three areas of avionics: Navigation, Sensory, and Communications. Table 1 shows the observation numbers of each piece of equipment and the class to which it belongs. For instance, observation 9 is a piece of navigations equipment that is used in a fighter. Since there is no sensory equipment used in cargo type aircraft, no observations are present there. The numbers in parenthesis indicates the quantity of observations in each category. Thus 18 LRUs are used in bombers and 16 LRUs are sensory type equipment. The numbers in the corners of the inner rectangles indicate the number of observations which fall in the respective interactive classes. There are 4 observations which are used in fighters in addition to being communications equipment. Table 2 lists the names of all the variables and their associated variable names used in the computer printouts of the regressions. Also, listed are the units in which the variables are expressed. The quantitative independent variables and the dependent variables are defined in Volume I of this report. The indicator variables (qualitative independent variables) need some further clarification.

BOMBER and CARGO are indicator variables used to represent equipment that is used in bomber and cargo type aircrafts respectively. SENS and COMM are indicator variables indicating that the avionics areas of the equipment are sensory and communications respectively. It is noted that there is no indicator variable for fighter aircraft or navigation equipment. Using indicator variables in this fashion, that is having a "baseline" of each class or category, can be very informative. Without loss of generality, fighters are chosen as the "baseline" for the aircraft types and navigation equipment are chosen as the "baseline" for the avionics area. We can then find those members of a certain class that are significantly different from the baseline. As an example, if the indicator variable BOMBER is significant enough to be in the final equations for MTBMA, this may be interpreted to mean that the MTBMA for equipment used in bombers is statistically significantly different from the MTBMA for equipment used in fighters (the baseline). Conversely if COMM does not remain, this indicates that the MTBMA for communications equipment behaves in a similar

TABLE 1.

Qualitative Categories

	FIGHTERS (29)			BOMBERS (18)		CARGO (17)		
NAVIGATIONS (35)	1	6	11	15	21	27	33	38
	2	7	12	17	22	28	34	39
	3	8	13	18	24	29	35	
	4	9		19	25	31	36	
	5	10		20	26	32	37	
			13		10			12
SENSORY (16)	40	45	54	56				
	41	46	55	51				
	42	47		52				
	43	48		53				
	44	49						
			12		4			0
COMMUNICATIONS (13)	56			60		64		
	57			61		65		
	58			62		66		
	59			63		67		
						68		
			4		4			5

TABLE 2.

Variables Used in the Regressions

Independent Variables

"Indicator"	Quantitative
X1M = (BOMBER - $\overline{\text{BOMBER}}$)	X8 = Unit price
X2M = (CARGO - $\overline{\text{CARGO}}$)	X9 = Volume
X3M = (SENS - $\overline{\text{SENS}}$)	X10 = Weight
X4M = (COMM - $\overline{\text{COMM}}$)	X11 = Components Count
X5 = X1 \times X3	X12 = Components density
X6 = X1 \times X4	X13 = % Digital
X7 = X2 \times X4	X14 = % Analog
	X15 = % Electro-mechanical
	X16 = % Power supply
	X17 = % Transmitter
	X18 = % Solid state
	X19 = Power Dissipation
	X20 = Utilization factor
	X21 = % BIT/FIT

Dependent Variables

Y1 = Maintenance Manhours per Operating Hour (MMH/OH)
 Y2 = Mean Time Between Failure (MTBF)
 Y3 = Mean Time Between Maintenance Actions (MTBMA)
 Y4 = Logistics Support Cost per Operating Hour (LSC/OH)
 Y5 = Training Cost per Operating Hour (TRAIN/OH)
 Y6 = Not Repairable This Station (NRTS)

manner as that of navigation equipment (the baseline). There also exists the possibility that communications equipment used in cargo type aircraft might have a significantly different effect on the dependent variable from that of navigations equipment used in fighters.

Three indicator variables (which are products of the four initial indicator variables) that can be used to determine the effects of such interactions are: BOMBER x SENS, BOMBER x COMM and CARGO x COMM. In the regressions however, the 7 indicator variables used are the ones shown in Table 2, where the bar above the variables indicate the mean. This is done in order to reduce the sometimes high correlation between the indicator variables and their products. If any of the three interactive variables X5, X6 and X7 are significant, then the analysis of the MTBMA example (above paragraph) will have quite a different interpretation. If interactions prove to be significant (as was the case in all regressions equations obtained in this study), the interpretation of how the levels with which the two classes (aircraft type, avionics area) compare with their baseline should not be used, but the analyst should find a means of interpreting which specific interactions are significantly different from which others.

Returning to Appendix A, we see three lines of information associated with each observation. The first line lists the 7 indicator variables, the second the (quantitative) independent variables and the third line are the 6 dependent variables. Thus observation 2 is a piece of navigation equipment used in a fighter with weight = 36.60, % solid state = 73. and MTBMA = 274.

Initially 85 LRUs were considered for the study. Many of the observations were dropped from the analysis because of the lack of data or the difficulty in obtaining the necessary data. Other observations, such as equipment which had not been in the Air Force inventory long enough to experience "good" data, were discarded so as not to introduce bias in the results. In addition a couple of the observations had missing dependent variable data and were omitted for that particular fit. Once all the data has been collected, there should be a panel of qualified experts on the studied equipment to determine the validity

of each data element in the data base. This was done to a limited extent in this study (because of time constraints).

Many times the statistics, plots, tables and techniques indicate that some observations do not behave like the remainder of the data. Besides other possible subjective variables, curvature may be causing this instability. In addition to the variables shown in Table 3, two transformations of the independent variable (the square and natural logarithm) and a transformation of the dependent variable (natural logarithm) are introduced into the regressions when curvature is indicated. The natural logarithm transformation is considered for those variables whose range is contained in the positive real numbers.

Since the LLSCFP allows six card columns to identify the names of the variables, alphanumeric representations consisting of six letters or less are used in computer printouts. Using X8 as an example, the transformed independent variables are of the form

$$X8M = (X8 - \bar{X8}) ,$$

$$X8DSQ = (X8 - d8)^2 ,$$

and $LN X8 = \ln X8$

where the bar indicates the mean, d8 is the d-statistic of variable X8 and ln is the natural logarithm. Table 3 shows the d-statistic and mean for each of the variables used in the regressions.

Before beginning any regressions, the data must be critically analyzed for outliers (impossible values) and for what is known as "Nested Data." The data is said to be "Nested" if some of the observations have all or nearly all the same or approximate x_i -values. Obviously outliers would have a significant impact on the fitted coefficients, thereby yielding the incorrect relationships. If the equations are fitted without checking to determine whether or not the data are nested, the wrong factors may be significant. The analysis of "Nested Data" was first introduced into the statistical literature by Daniel and Wood ([1], Chapter 8).

Since there is human intervention in the development, collection and analysis of data, outliers might not immediately become apparent.

TABLE 3

D-Statistic and Mean

<u>MMH/OH</u>			<u>MTBF</u>		
I	MEAN(I)	DSTAT(I)	I	MEAN(I)	DSTAT(I)
8	27173.650	133726.400	8	27536.100	133828.600
9	1438.048	3307.065	9	1483.726	3337.016
10	34.981	64.404	10	36.221	65.088
11	909.889	2948.044	11	940.016	2965.510
12	0.924	2.489	12	0.924	2.489
13	7.556	43.028	13	7.677	43.038
14	62.683	49.183	14	61.677	48.615
15	16.000	46.378	15	16.258	46.403
16	3.429	49.827	16	3.484	49.829
17	10.492	40.395	17	11.065	40.258
18	61.297	51.914	18	61.044	52.254
19	368.968	723.684	19	382.419	729.178
20	1.657	1.681	20	1.645	1.679
21	4.825	26.957	21	4.694	27.148

<u>MTBMA</u>			<u>LSC/OH</u>		
I	MEAN(I)	DSTAT(I)	I	MEAN(I)	DSTAT(I)
8	27536.100	133828.600	8	26943.220	133606.300
9	1483.726	3337.016	9	1457.984	3311.530
10	36.221	65.088	10	35.570	64.314
11	940.016	2965.510	11	927.746	2956.742
12	0.924	2.489	12	0.933	2.501
13	7.677	43.038	13	7.556	43.028
14	61.677	48.615	14	63.349	48.895
15	16.258	46.403	15	14.937	46.991
16	3.484	49.829	16	3.429	49.827
17	11.065	40.258	17	10.889	40.172
18	61.044	52.254	18	61.138	51.898
19	382.419	729.178	19	374.159	722.249
20	1.645	1.679	20	1.639	1.681
21	4.694	27.148	21	4.556	27.288

TABLE 3

D-Statistic and Mean (Con't.)

<u>TRAIN/OH</u>			<u>NRTS</u>		
I	MEAN(I)	DSTAT(I)	I	MEAN(I)	DSTAT(I)
8	26950.100	133922.500	8	27288.080	133763.300
9	1445.145	3305.984	9	1475.339	3321.294
10	34.955	64.418	10	36.005	64.594
11	889.468	2982.834	11	936.758	2961.209
12	0.904	2.522	12	0.938	2.505
13	7.677	43.038	13	7.677	43.038
14	62.516	49.242	14	63.468	49.468
15	15.823	46.514	15	14.468	45.651
16	3.484	49.828	16	3.484	49.828
17	10.661	40.474	17	11.065	40.258
18	61.108	51.989	18	62.108	52.151
19	372.097	723.719	19	378.529	723.518
20	1.646	1.680	20	1.645	1.679
21	4.839	26.952	21	4.694	27.149

However, the computerized plots of an initial regression may point them out. Figures 13-17 show summary computer printouts of an initial run (Pass 03) after fitting the equation

$$y = b_0 + \sum_{i=1}^{21} b_i x_i ,$$

where $Y = \ln \text{MTBMA}$ and $x_i = X_i$, $i = 1, 2, \dots, 21$, are the 21 independent variables. The statistics (Figure 13) are not significant and the stars, *, indicate error is too large to be printed out in the space provided. The cumulative standard deviation table (Figure 15) shows that there is a serious lack of fit. The cumulative distribution plot (Figure 16) and the fitted value plot (Figure 17) indicate that there is a single oversized residual (possibly an outlier). Since there is also the possibility of curvature, a fit is made with $Y = \ln Y_3 = \ln \text{MTBMA}$ with printouts shown in Figure 18-22. The statistics using the natural logarithm are greatly improved but Figures 21 and 22 also (although not as profound as before) indicate that an oversized residual is present.

In Figures 14 and 19, under the heading "ORDERED BY RESIDUALS", we immediately see that observation 36 with WUC 7171A is the culprit. In addition Figure 13 shows that the maximum value of the dependent variable, MTBMA is 31,490 hours, and hence there is an observation (piece of equipment) in data base with such a large MTBMA. On investigating the data collection system (AFM 66-1 "6-LOG") from which the MTBMAs were extracted, it was found that observation 36 with $\text{MTBMA} = 31,490$ was a subassembly of an LRU (called an SRU) and not a LRU. Since the study is based on LRUs, leaving this particular observation in would bias the results, and therefore another observation with WUC 71716 was used in its place.

In addition to impossible values and discrepancies in the data systems, outliers may be caused by simple keypunch errors. If those errors are profound, the computerized plots should reflect the discrepancies. In many of the regressions considered throughout this report, the plots were helpful in detecting those observations which

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

OLD MODEL PASS 03 DEP VAR 11 Y3 MIN Y = 4.5500 01 MAX Y = 3.1400 04 RANGE Y = 3.1450 04

IND. VAR(I)	NAME	COEF. R(I)	S.E. COEF.	T-VALUE	R(I)SQD	MIN X(I)	MAX X(I)	RANGE X(I)	REL. INF. X(I)
1	X1M	2.673150 04	2.580 03	6.3	0.7650	-2.7400-01	7.2600-01	1.0000 00	0.03
2	X2M	8.324450 02	3.870 03	1.2	0.0338	-2.7400-01	7.2600-01	1.0000 00	0.12
3	X3M	3.818310 03	1.970 03	0.9	0.5809	-2.7400-01	7.2600-01	1.0000 00	0.06
4	X4M	-6.273200 03	1.810 03	0.3	0.4200	-2.7400-01	7.2600-01	1.0000 00	0.02
5	X5M	1.367810 03	3.620 03	0.4	0.3464	-2.7400-01	7.2600-01	1.0000 00	0.03
6	X6M	2.927650 02	3.420 03	0.1	0.3671	-2.7400-01	7.2600-01	1.0000 00	0.01
7	X7M	-4.556970 03	3.680 03	1.2	0.0812	-2.7400-01	7.2600-01	1.0000 00	0.11
8	X8M	6.719000 01	1.710-02	0.5	0.2129	-2.7400-01	7.2600-01	1.0000 00	0.09
9	X9M	7.517210 01	0.210-01	0.6	0.8540	1.5800 02	3.2400 05	3.2300 05	0.20
10	X10M	-6.114820 01	0.210-01	1.3	0.0100	1.5800 02	3.2400 05	6.1700 03	0.44
11	X11M	-8.807540 01	0.640-01	1.1	0.6400	1.5800 02	1.7370 02	1.7250 02	0.19
12	X12M	-3.816930 02	0.140 02	0.4	0.0792	9.9900 00	7.6380 03	6.6900 00	0.08
13	X13M	-2.292210 02	5.830 02	0.4	0.0982	0.0	1.0000 02	1.0000 02	0.73
14	X14M	-2.174640 02	5.680 02	0.4	0.0991	0.0	1.0000 02	1.0000 02	0.60
15	X15M	-2.174640 02	5.720 02	0.5	0.0969	0.0	1.0000 02	1.0000 02	0.82
16	X16M	-2.580900 02	5.660 02	0.4	0.0975	0.0	1.0000 02	1.0000 02	0.64
17	X17M	-2.077800 02	2.290 01	0.4	0.5589	0.0	1.5400 03	1.5300 03	0.12
18	X18M	9.255170 00	2.430 03	1.1	0.5659	7.9800 01	2.3800 08	2.8000 00	0.04
19	X19M	-2.243640 00	2.430 03	0.3	0.8297	3.8800 01	6.1000 01	6.1000 01	0.10
20	X20M	-6.396220 02	6.910 01	1.4	0.5676	0.0			
21	X21M	9.462110 01							

NO. OF OBSERVATIONS 62
 NO. OF IND. VARIABLES 21
 RESIDUAL DEGREES OF FREEDOM 40
 F-VALUE 0.7
 RESIDUAL ROOT MEAN SQUARE 4395.1931814
 RESIDUAL MEAN SQUARE *****
 RESIDUAL SUM OF SQUARES *****
 TOTAL SUM OF SQUARES *****
 MULT. CORREL. COEF. SQUARED .2661

REQUIRED X(I) PRECISION
 (DIGIT RIGHT OF DECIMAL POSITIVE,
 LEFT OF DECIMAL NEGATIVE)

IND. VAR(I)	DIGIT
1	1
2	1
3	1
4	1
5	1
6	1
7	1
8	-5
9	-4
10	-2
11	-4
12	1
13	1
14	1
15	1
16	1
17	1
18	-2
19	-3
20	1
21	-2

FIGURE 13

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

OBS. MODEL PASS 03 DEP VAR 11 Y3									
ORDERED BY COMPUTER INPUT									
IDENT.	OROV.	SS DISTANCE	OBS. Y	FITTED Y	RESIDUAL	OBS. Y	FITTED Y	ORDERED RESID.	SEQ
7120	1	2	160.308	450.276	-290.776	31404.800	7641.836	2882.844	1
7121	2	1	273.788	-1581.442	225.142	180.900	-2652.378	2971.278	2
7122	3	2	161.800	-663.148	814.148	51	7559.420	4802.355	3
7123	4	13	119.600	-853.412	972.812	2	273.788	2727.233	4
7124	5	2	135.400	-123.695	29.735	45	161.482	2253.142	5
7125	6	2	478.128	-1264.719	1542.818	45	151.828	2243.865	6
7126	7	5	352.800	2425.667	95.133	53	6878.300	2194.145	7
7127	8	5	3530.720	2178.915	1362.755	42	117.300	2075.055	8
7128	9	3	94.300	1933.208	-1738.908	17	57.500	1915.557	9
7129	10	6	529.300	720.505	-191.505	6	476.100	1772.840	10
7130	11	0	736.000	2519.204	-1783.204	8	3559.700	1545.818	11
7131	12	0	213.000	9279.943	-9062.943	40	195.500	1331.822	12
7132	13	4	999.700	3200.515	-2223.815	55	185.200	1255.433	13
7133	14	5	97.500	-1625.330	1772.830	20	373.722	1182.889	14
7134	15	4	125.900	-285.378	297.278	67	116.400	1112.518	15
7135	16	4	378.700	2075.811	-1126.811	4	119.600	972.812	16
7136	17	2	178.200	-112.800	41.600	3	151.000	814.148	17
7137	18	3	45.700	-185.953	241.653	61	78.000	784.093	18
7138	19	6	235.700	2045.053	-2255.353	69	61.100	743.367	19
7139	20	5	646.700	2035.185	-2522.885	57	119.600	668.628	20
7140	21	5	115.100	2042.760	-1927.660	56	78.000	625.747	21
7141	22	2	68.600	1711.361	-1578.161	60	342.000	584.945	22
7142	23	4	130.200	1240.276	-271.076	24	232.700	548.945	23
7143	24	6	336.000	4514.997	-5225.727	22	45.500	511.532	24
7144	25	9	280.200	3454.185	-3328.985	41	150.500	418.553	25
7145	26	3	72.000	274.860	-202.860	41	150.500	418.553	26
7146	27	3	167.800	2752.083	-2584.283	22	45.500	244.592	27
7147	28	4	127.200	3454.185	-3328.985	48	195.500	185.705	28
7148	29	6	284.400	3565.671	-3281.271	38	272.400	151.532	29
7149	30	5	31494.000	7641.836	-2852.964	5	133.400	95.143	30
7150	31	4	272.400	119.778	-161.638	5	133.400	95.143	31
7151	32	2	164.400	119.778	-161.638	54	94.700	20.725	32
7152	33	10	1465.500	4652.614	-3187.114	21	1781.020	-0.000	33
7153	34	4	130.200	3334.968	-3204.768	31	72.000	-112.500	34
7154	35	2	126.500	-1814.047	1931.37	1	151.500	-151.500	35
7155	36	2	1265.000	2192.601	-1027.37	50	318.700	-221.776	36
7156	37	2	1065.000	182.667	-182.667	29	330.000	-682.145	37
7157	38	5	181.800	-2281.966	2242.366	47	158.100	-719.200	38
7158	39	3	161.400	-2242.366	2194.145	58	184.200	-743.376	39
7159	40	3	161.400	836.676	-735.276	43	1365.000	-845.591	40
7160	41	4	165.500	9.775	185.725	26	133.200	-1422.867	41
7161	42	3	195.500	-1116.372	1313.822	28	133.200	-1578.161	42
7162	43	2	345.800	2355.205	-2009.405	9	94.300	-1578.161	43
7163	44	2	7520.000	4802.355	-2727.245	11	736.200	-1738.008	44
7164	45	5	837.200	3635.956	-2798.756	26	113.100	-1738.008	45
7165	46	28	6878.300	4802.355	-2075.955	37	124.600	-1902.885	46
7166	47	4	904.700	-2275.005	2275.005	27	69.600	-1912.85	47
7167	48	5	913.830	3065.656	-2151.826	50	345.000	-1912.85	48
7168	49	2	78.200	743.927	-665.727	40	1398.700	-224.385	49
7169	50	2	124.200	905.747	-781.547	64	199.700	-224.385	50
7170	51	2	115.600	625.747	-509.147	15	930.700	-224.385	51
7171	52	2	319.700	983.855	-664.155	62	240.000	-224.385	52
7172	53	2	61.120	-733.803	794.923	25	588.700	-224.385	53
7173	54	2	245.600	525.114	-279.514	33	167.000	-224.385	54
7174	55	3	172.000	-695.728	868.728	52	837.200	-224.385	55
7175	56	5	188.600	2865.867	-2677.267	55	913.830	-224.385	56
7176	57	3	55.200	-1205.233	1255.433	13	213.000	-224.385	57
7177	58	2	130.200	1024.791	-894.591	39	1485.000	-224.385	58
7178	59	2	110.400	-1002.110	1112.510	34	127.200	-224.385	59
7179	60	7	342.000	-242.945	584.945	32	259.200	-224.385	60
7180	61								
7181	62								
7182	63								
7183	64								
7184	65								
7185	66								
7186	67								
7187	68								
7188	69								
7189	70								
7190	71								
7191	72								
7192	73								
7193	74								
7194	75								
7195	76								
7196	77								
7197	78								
7198	79								
7199	80								
7200	81								
7201	82								
7202	83								
7203	84								
7204	85								
7205	86								
7206	87								
7207	88								
7208	89								
7209	90								
7210	91								
7211	92								
7212	93								
7213	94								
7214	95								
7215	96								
7216	97								
7217	98								
7218	99								
7219	100								

FIGURE 14

OLM MODEL PASS 83 DEP VAR 11 Y3
 LINEAR LEAST-SQUARES CURVE FITTING PROGRAM
 STANDARD DEVIATION ESTIMATED FROM RESIDUALS OF NEIGHBORING OBSERVATIONS (OBSERVATIONS 1 TO 4 APART IN FITTED Y ORDER).
 RESIDUAL ROOT MEAN SQUARE OF FITTED EQUATION: 4395.19

NO.	CUMULATIVE STD DEV	ORDERED BY MSSD			ORDERED BY FITTED Y			SER.
		MSSD	OROV.	DEL RESIDUALS	MSSD	DEL RESIDUALS	FITTED Y	
1	718.45	2.0	51	651.38	45.84	727.89	-2459.38	1
2	382.27	0.8	57	41.40	2.99	49.24	-2081.99	2
3	281.37	0.8	61	16.99	44.73	61.28	-2042.34	3
4	216.65	0.28	37	39.33	36.75	333.79	-1981.44	4
5	194.87	0.28	45	142.92	45.84	158.52	-1814.86	5
6	784.87	0.04	28	3427.84	4.81	517.41	-1675.34	6
7	882.53	0.25	8	1255.64	42.63	58.39	-1208.23	7
8	4782.58	0.06	32	29278.76	38.98	227.28	-118.52	8
9	4959.78	0.12	55	5170.43	3.23	428.31	-1084.72	9
10	5229.73	0.12	55	5128.13	23.11	148.58	-852.41	10
11	4584.62	0.12	58	123.96	22.21	162.72	-733.89	11
12	4297.53	0.12	7	1933.55	0.8	16.98	-653.14	12
13	4245.93	0.16	26	3284.87	8.23	19.15	-625.75	13
14	3951.33	0.17	3	112.19	8.17	68.79	-625.75	14
15	3892.97	0.17	3	68.79	8.17	68.79	-625.75	15
16	3469.61	0.18	61	187.95	2.88	35.32	-625.75	16
17	3271.43	0.18	68	91.35	18.84	83.68	-625.75	17
18	3293.76	0.18	61	61.35	18.84	83.68	-625.75	18
19	2933.82	0.18	61	61.35	18.84	83.68	-625.75	19
20	2882.14	0.22	68	272.89	1.99	127.68	-199.19	20
21	2668.82	0.23	44	272.89	1.99	127.68	-199.19	21
22	2548.47	0.23	3	18.15	51.82	156.29	-164.55	22
23	2442.35	0.25	23	97.54	50.47	131.93	-164.55	23
24	2493.78	0.38	15	3329.52	50.85	364.49	-183.78	24
25	2165.98	0.38	44	591.28	6.49	88.92	-118.27	25
26	2375.95	0.39	48	772.44	18.44	188.18	-455.98	26
27	2375.95	0.47	15	174.55	43.51	538.08	-455.98	27
28	2226.85	0.62	1	291.78	96.78	735.58	-728.58	28
29	2135.82	0.74	9	185.89	3.45	785.13	-83.58	29
30	2077.42	0.83	44	316.11	8.12	127.58	94.78	30
31	1921.23	1.13	67	208.37	1.60	221.43	989.33	31
32	1874.51	1.21	35	482.57	4.58	166.35	989.33	32
33	1922.44	1.26	17	232.92	4.58	166.35	1024.79	33
34	1864.95	1.40	27	84.14	7.58	858.82	1040.24	34
35	1819.75	1.40	37	133.17	7.58	858.82	1040.24	35
36	1822.34	1.40	15	1889.46	38.81	1626.18	1711.36	36
37	1759.84	1.41	64	258.46	49.88	1811.19	1833.32	37
38	1722.75	1.41	47	317.52	4.58	9.74	1833.32	38
39	1697.24	1.41	67	388.82	2.00	39.33	2037.18	39
40	1647.68	1.44	58	188.46	4.69	3333.95	2037.18	40
41	1641.28	1.45	48	1255.61	46.44	2268.39	2037.18	41
42	1559.32	1.64	59	271.11	42.42	1139.78	2178.92	42
43	1577.58	1.69	59	221.43	2.59	62.89	2192.68	43
44	1626.14	1.76	8	3365.19	1.97	2890.55	2256.96	44
45	1591.64	1.85	62	74.78	22.28	1878.44	2256.96	45
46	1627.61	1.97	58	2080.53	16.35	492.22	2350.28	46
47	1576.61	1.99	24	127.68	2.65	3424.28	2350.28	47
48	1615.68	2.07	54	3133.69	21.83	3719.67	2350.28	48
49	1593.74	2.24	1	493.35	28.92	292.93	2350.28	49
50	1584.96	2.24	5	321.48	8.25	67.53	2752.98	50
51	1554.34	2.32	6	745.82	2.57	851.27	2947.85	51
52	1559.92	2.32	6	728.92	3.52	851.27	2947.85	52
53	1511.34	2.56	62	22.84	41.27	1388.62	3275.98	53
54	1580.96	2.57	15	861.27	30.16	45.71	3454.18	54
55	1474.93	2.59	64	62.89	1.21	482.57	3454.18	55
56	1495.31	2.62	7	3372.68	49.33	253.52	3635.91	56
57	1535.00	2.65	62	374.28	6.36	129.79	3635.91	57
58	1531.62	2.65	20	703.55	6.31	5257.92	4667.61	58
59	1589.84	2.72	66	692.57	8.8	651.38	4822.39	59
60	1486.24	2.85	68	126.36	48.28	7953.28	4822.39	60
61	1463.28	2.88	57	76.72	8.86	2878.76	5515.88	61
62	1440.31	2.88	56	35.32	47.11	777.13	7641.84	62

FIGURE 15

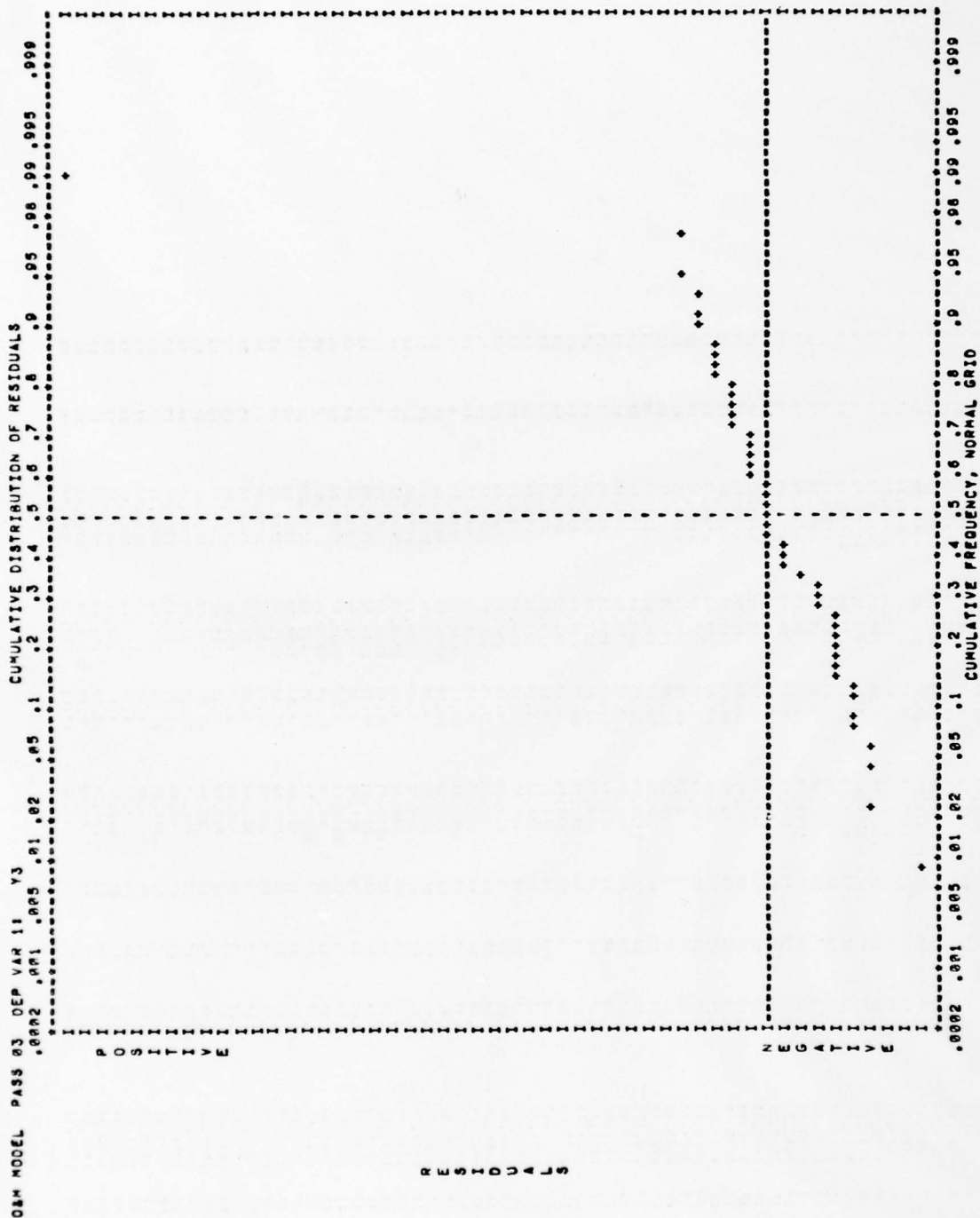


FIGURE 16

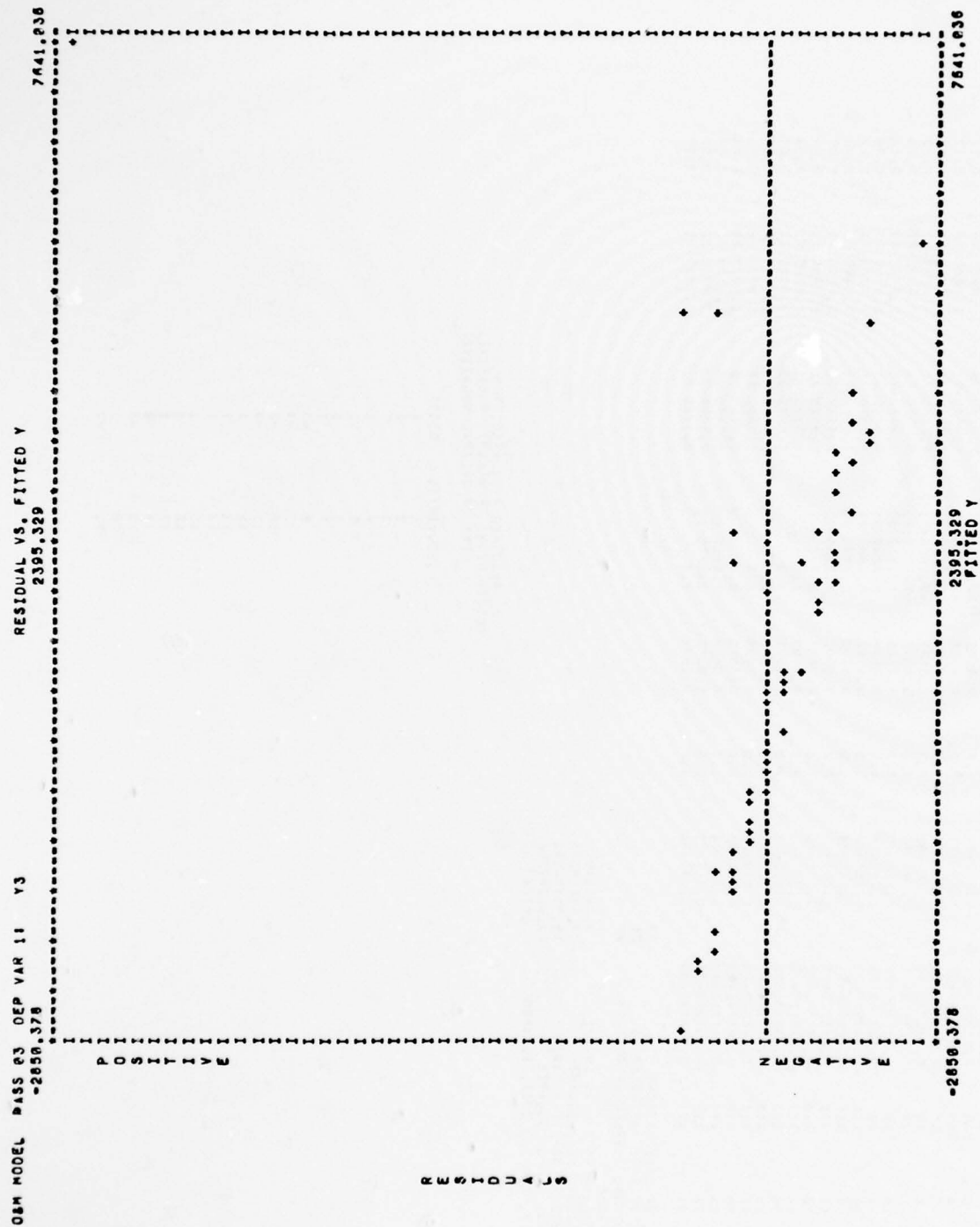


FIGURE 17

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

Q&M MODEL PASS 03 DEP VAR 21 LNTS MIN Y = 3.8140 PP MAX Y = 1.0340 01 RANGE Y = 6.5490 00

IND. VAR (I)	NAME	COEF. R(I)	S.E. COEF.	T-VALUE	R(I)ISDRD	MIN X(I)	MAX X(I)	RANGE X(I)	REL. INF. X(I)
1	X1M	7.793620 PP	5.540 PP	1.1	0.7558	-2.7490 PP	7.2690 PP	1.000 PP	0.09
2	X2M	5.856870 PP	6.580 PP	1.3	0.8338	-2.7490 PP	7.2690 PP	1.000 PP	0.14
3	X3M	8.803330 PP	4.230 PP	1.7	0.8899	-2.5890 PP	7.4290 PP	1.000 PP	0.11
4	X4M	7.255330 PP	3.890 PP	2.0	0.8288	-2.1990 PP	7.5990 PP	1.000 PP	0.12
5	X5	-7.656490 PP	7.730 PP	0.9	0.7464	-2.8330 PP	5.3870 PP	7.4290 PP	0.08
6	X6	6.770220 PP	8.270 PP	0.8	0.7871	-2.1650 PP	5.7350 PP	7.920 PP	0.02
7	X7	1.743110 PP	7.690 PP	0.2	0.4812	-2.1650 PP	5.7350 PP	7.920 PP	0.09
8	X8	-7.315130 PP	3.670 PP	0.8	0.7129	1.5890 PP	3.2490 PP	3.230 PP	0.14
9	X9	2.856460 PP	1.930 PP	1.5	0.8548	3.0990 PP	6.2490 PP	8.1790 PP	0.36
10	X10	2.903130 PP	1.330 PP	3.1	0.9198	1.2990 PP	1.7370 PP	1.7250 PP	1.09
11	X11	-4.144290 PP	1.540 PP	1.5	0.8408	9.0990 PP	7.6380 PP	7.6390 PP	0.28
12	X12	-0.385360 PP	1.750 PP	0.4	0.5792	4.9230 PP	6.6740 PP	6.690 PP	0.07
13	X13	7.253370 PP	1.250 PP	0.1	0.5982	0.0	1.0990 PP	1.0990 PP	0.28
14	X14	-1.820370 PP	1.210 PP	0.1	0.5993	0.0	1.0990 PP	1.0990 PP	0.14
15	X15	-0.372110 PP	1.220 PP	0.0	0.5591	0.0	1.0990 PP	1.0990 PP	0.01
16	X16	-2.073120 PP	1.220 PP	0.2	0.5969	0.0	1.0990 PP	1.0990 PP	0.32
17	X17	5.437090 PP	1.210 PP	0.8	0.5975	0.0	1.0990 PP	1.0990 PP	0.01
18	X18	2.727900 PP	4.910 PP	0.6	0.4599	0.0	1.0990 PP	1.0990 PP	0.04
19	X19	-6.610770 PP	4.400 PP	1.5	0.4559	7.0990 PP	1.6480 PP	1.6330 PP	0.17
20	X20	-1.241320 PP	5.210 PP	0.2	0.4297	3.0990 PP	2.3390 PP	2.0990 PP	0.03
21	X21	2.934940 PP	1.480 PP	2.0	0.5876	0.0	6.1090 PP	6.1090 PP	0.27

NO. OF OBSERVATIONS 82
 NO. OF IND. VARIABLES 21
 RESIDUAL DEGREES OF FREEDOM 40
 F-VALUE 4.0
 RESIDUAL ROOT MEAN SQUARE 0.94294949
 RESIDUAL MEAN SQUARE 2.48915375
 TOTAL SUM OF SQUARES 35.56414993
 TOTAL SUM OF SQUARES 199.92202210
 MULT. CORREL. COEFF. SQUARED .6764

REQUIRED X(I) PRECISION
 (DIGIT RIGHT OF DECIMAL POSITIVE,
 LEFT OF DECIMAL NEGATIVE)

IND. VAR (I)	DIGIT
1	1
2	1
3	1
4	1
5	1
6	1
7	1
8	1
9	-5
10	-4
11	-2
12	-4
13	1
14	1
15	1
16	1
17	1
18	-2
19	-3
20	1
21	-2

FIGURE 18

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

Q&M MODEL PASS #3 DEP VAR 21 LNY3

ORDERED BY COMPUTER INPUT				ORDERED BY RESIDUALS			
IDENT	OBSV.	WSS DISTANCE	OBS. Y	FITTED Y	RESIDUAL	OBSV.	OBS. Y
71620	1	1.	5.096	5.833	-0.738	36	10.358
73330	2	0.	5.612	5.168	0.444	8	8.172
71150	3	0.	5.081	5.075	0.007	7	7.832
71160	4	1.	4.734	5.685	-0.951	28	6.217
71800	5	0.	4.493	5.339	-0.846	6	6.166
71800	6	0.	6.166	5.048	1.118	9	5.048
71710	7	3.	6.632	6.368	0.264	20	7.709
72460	8	3.	6.172	6.468	-0.296	18	4.818
71450	9	1.	4.544	5.248	-0.704	63	5.153
71450	10	2.	6.271	5.086	1.185	47	4.683
71680	11	2.	5.821	5.846	-0.025	45	5.684
71040	12	2.	5.087	6.367	-1.280	51	8.327
71080	13	2.	6.087	5.691	0.396	67	4.764
71080	14	2.	4.768	4.514	0.254	2	5.612
73050	15	9.	4.795	4.810	0.015	55	8.836
73050	16	3.	6.217	6.820	-0.603	21	7.445
73050	17	2.	7.485	7.117	0.368	38	5.697
73050	18	10.	3.610	4.429	-0.819	10	6.271
73040	19	2.	5.454	5.497	-0.043	40	7.177
73040	20	3.	4.728	6.350	-1.622	57	7.384
73040	21	2.	4.243	5.117	-0.874	42	4.765
72040	22	9.	4.892	4.781	0.111	46	5.823
72040	23	4.	5.799	4.894	0.905	59	5.767
72040	24	5.	4.277	4.415	-0.138	28	4.892
71140	25	2.	5.667	7.061	-1.394	17	4.989
71140	26	2.	5.080	5.720	-0.640	15	4.987
72040	27	3.	4.848	5.351	-0.503	3	5.081
72040	28	1.	5.559	6.841	-1.282	54	6.898
71110	29	2.	4.404	7.517	-3.113	66	4.938
72040	30	2.	5.057	5.116	0.060	88	8.835
72040	31	2.	7.384	7.094	0.290	24	5.458
73050	32	3.	7.177	6.944	0.233	43	7.143
74000	33	1.	4.840	5.572	-0.732	61	4.357
74000	34	1.	4.765	4.537	0.227	85	4.811
74000	35	2.	7.143	7.184	-0.041	31	4.277
74000	36	2.	5.945	6.425	-0.480	56	4.359
74000	37	5.	5.284	4.516	0.768	58	4.822
74000	38	12.	5.023	4.831	0.192	11	6.681
74000	39	42.	4.683	4.886	-0.203	62	5.528
74000	40	9.	5.276	5.584	-0.308	64	5.245
74000	41	13.	5.646	4.757	0.889	48	5.534
77000	42	1.	6.027	6.363	-0.336	41	5.276
77000	43	1.	6.738	6.402	0.336	68	4.113
77000	44	1.	6.738	7.172	-0.434	25	6.475
77000	45	3.	6.835	6.808	0.027	35	6.658
73050	46	2.	6.818	7.591	-0.773	52	6.738
73050	47	2.	4.359	4.553	-0.194	5	4.893
73050	48	1.	4.784	4.535	0.249	37	5.116
73050	49	2.	5.767	5.923	-0.156	44	5.945
73050	50	2.	4.115	5.059	-0.944	34	5.846
73050	51	1.	4.357	4.468	0.111	50	5.886
73050	52	1.	5.528	5.766	-0.238	53	5.372
73050	53	1.	5.153	4.448	0.705	41	5.266
73050	54	1.	4.911	4.145	0.766	1	5.266
73050	55	2.	4.936	4.048	0.888	55	5.117
73050	56	2.	4.724	4.235	0.489	27	4.243
73050	57	2.	5.035	5.060	-0.025	4	4.784
73050	58	4.	5.035	5.060	-0.025	13	5.368
73050	59	4.	5.035	5.060	-0.025	59	5.368
73050	60	4.	5.035	5.060	-0.025	13	5.368
73050	61	4.	5.035	5.060	-0.025	59	5.368
73050	62	4.	5.035	5.060	-0.025	13	5.368
73050	63	4.	5.035	5.060	-0.025	59	5.368
73050	64	4.	5.035	5.060	-0.025	13	5.368
73050	65	4.	5.035	5.060	-0.025	59	5.368
73050	66	4.	5.035	5.060	-0.025	13	5.368
73050	67	4.	5.035	5.060	-0.025	59	5.368
73050	68	4.	5.035	5.060	-0.025	13	5.368

END OF DATA

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM									
ORDM MODEL PASS #3 DEP VAR 21 LAY3			RESIDUAL ROOT MEAN SQUARE OF FITTED EQUATIONS				0.04		
STANDARD DEVIATION ESTIMATED FROM RESIDUALS OF NEIGHBORING OBSERVATIONS (OBSERVATIONS 1 TO 4 APART IN FITTED Y ORDER).									
NO.	CUMULATIVE		ORDERED BY MSSD		ORDERED BY MSSD		ORDERED BY FITTED Y		SEQ.
	STD DEV	MSSD	OBSV.	DEL	OBSV.	DEL	OBSV.	DEL	
1	0.18	0.03	51	0.03	22.04	0.17	4.01	18	1
2	0.28	0.08	57	0.08	37.15	0.75	4.07	47	2
3	0.28	0.08	61	0.08	4.01	0.68	4.14	65	3
4	0.32	0.20	37	0.41	12.04	0.61	4.23	67	4
5	0.39	0.01	65	0.62	12.04	0.47	4.41	31	5
6	0.37	0.02	7	0.25	13.85	1.32	4.43	22	6
7	0.38	0.06	25	0.36	0.09	0.62	4.44	63	7
8	0.44	0.06	6	1.11	0.0	0.24	4.47	61	8
9	0.65	0.09	20	1.75	1.14	0.42	4.47	69	9
10	0.72	0.29	63	1.07	9.17	0.53	4.51	17	10
11	0.73	0.29	63	0.82	6.56	0.34	4.52	45	11
12	0.73	0.14	43	0.73	0.6	0.42	4.56	57	12
13	0.79	0.17	20	1.38	5.70	0.48	4.56	56	13
14	0.77	0.18	44	0.48	3.51	0.31	4.56	42	14
15	0.77	0.20	6	0.67	5.54	0.41	4.76	49	15
16	0.70	0.22	1	0.08	18.34	0.59	4.76	28	16
17	0.64	0.24	2	0.89	12.11	0.71	4.83	46	17
18	0.74	0.20	3	0.44	3.83	0.92	4.89	29	18
19	0.92	0.41	9	3.10	1.55	0.19	4.95	66	19
20	0.94	0.45	8	2.07	0.85	1.32	4.95	58	20
21	0.94	0.54	20	0.91	0.06	1.11	5.05	6	21
22	0.92	0.55	7	0.72	1.08	0.47	5.07	3	22
23	0.92	0.59	9	3.79	0.69	0.41	5.12	37	23
24	1.22	0.60	26	1.72	2.27	1.32	5.12	27	24
25	0.98	0.63	9	0.10	7.61	0.69	5.17	2	25
26	0.95	0.71	5	0.29	8.06	0.68	5.26	38	26
27	0.98	0.74	55	1.38	4.56	0.66	5.34	5	27
28	0.90	0.76	55	1.21	5.94	0.67	5.35	34	28
29	1.01	0.77	7	1.45	4.22	0.25	5.49	24	29
30	1.02	0.70	43	0.57	2.87	0.44	5.53	64	30
31	0.98	0.70	43	0.48	9.73	0.42	5.57	41	31
32	0.98	0.70	59	1	12.39	0.48	5.58	48	32
33	1.01	0.70	6	0.91	2.09	1.07	5.68	59	33
34	1.02	0.65	58	1.32	2.77	0.25	5.68	4	34
35	1.04	0.65	32	1.69	3.56	0.48	5.73	33	35
36	1.02	0.60	60	0.15	1.70	0.49	5.77	62	36
37	1.04	0.60	51	0.34	3.13	0.78	5.83	1	37
38	1.09	0.60	57	0.58	2.17	0.34	5.87	68	38
39	1.24	0.60	30	2.63	2.04	0.78	5.97	18	39
40	1.23	0.60	15	0.35	1.84	1.33	6.04	35	40
41	1.22	1.07	23	0.59	8.63	0.18	6.27	9	41
42	1.28	1.07	56	0.21	3.35	1.18	6.35	28	42
43	1.03	1.07	7	1.95	2.11	0.45	6.36	59	43
44	1.01	1.04	15	0.22	1.72	2.47	6.37	13	44
45	1.01	1.04	21	1.14	1.02	1.95	6.37	7	45
46	1.04	1.05	6	1.96	1.13	2.19	6.43	44	46
47	1.02	1.04	54	0.82	0.70	1.71	6.46	8	47
48	1.01	1.08	63	0.63	1.24	1.48	6.81	54	48
49	1.06	1.08	21	0.41	2.09	1.78	6.82	20	49
50	0.99	1.08	54	0.16	1.42	0.12	6.84	25	50
51	0.97	1.00	4	0.36	1.08	0.26	6.85	11	51
52	0.95	1.00	11	0.26	1.64	0.22	6.89	15	52
53	0.96	1.11	20	1.17	1.70	1.63	6.94	40	53
54	0.90	1.13	44	2.19	2.85	1.68	7.05	32	54
55	0.95	1.14	61	0.18	1.72	0.16	7.09	39	55
56	0.97	1.14	60	0.42	2.67	0.41	7.12	21	56
57	0.97	1.15	26	1.14	2.27	0.48	7.17	52	57
58	0.96	1.15	59	0.42	2.25	2.88	7.18	43	58
59	0.98	1.20	18	0.23	2.73	1.61	7.32	36	59
60	0.99	1.24	54	1.48	8.78	1.21	7.59	55	60
61	0.88	1.37	41	0.17	0.6	0.69	8.48	53	61
62	0.97	1.39	13	0.52	7.92	0.92	8.48	51	62

FIGURE 20

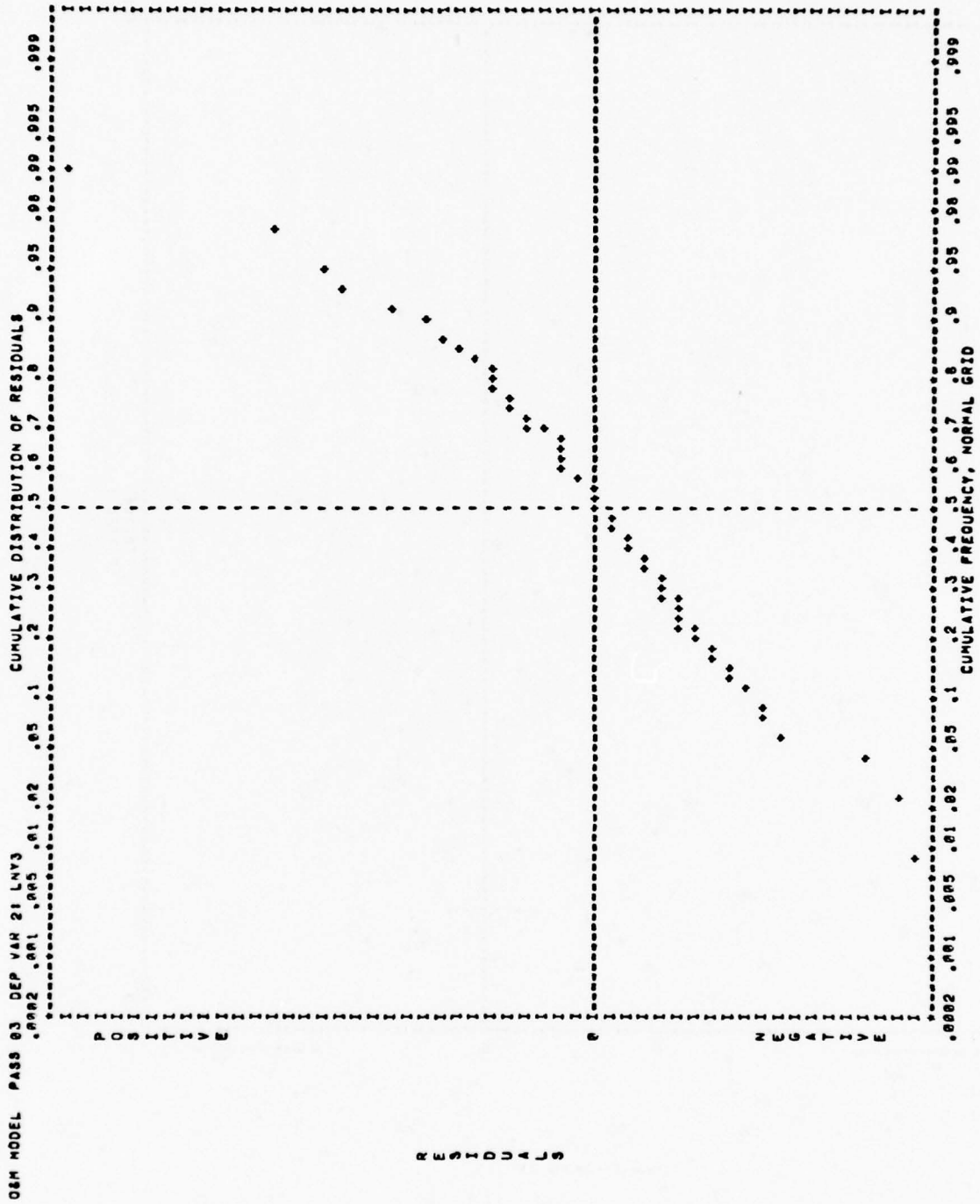


FIGURE 21

had not been in the Air Force inventory long enough to experience "good" data. These observations were dropped from the analysis in order to reduce bias.

As a means of determining whether the data are "nested", a computer program was written to sort the data table by each independent variable, x_i . For instance, Table 4 is a printout of the data ranked by the unit price. As can be seen there are only a few observations with the same x_i values, and hence no evidence of serious nesting exists. If it is determined that the data are nested, two fittings must be made: one on the nested data "within plots" and one "among plots". (See [1], Chapter 8).

After the data has been critically examined, and alternate LRUs considered where necessary, we are now ready to begin the regressions. As before, a fit is made (Pass 3) where Y_3 is the dependent variable (see Figures 23-27). Note that the statistics in Figure 23 have been greatly improved over that of Figure 13, which indicates the power of an outlier in the data. The fitted values plot (Figure 27), however, shows a strange trend in the residuals, that possibly the natural logarithm function can straighten out. Figures 28-32 show the results of fitting the same independent variable but with $\ln Y_3$ as the dependent variable. Here the statistics are slightly better than those of Figure 23, but the cumulative distribution plot shows an approximate straight line and the trend in the fitted values plot has disappeared.

The anxious analyst might feel at this point that the use of the natural logarithm transformation in the dependent variable is the appropriate form to use the equation. It might be, however, that other transformation (curvature) in the independent variables are needed in the equation to determine the correct form of the dependent variable. Consequently, both forms of the dependent variable should be fitted simultaneously, analyzing the statistics, plots and tables at each stage and introducing curvature whenever the statistics indicate. In developing several of the fitted equations such as MMH/OH, LSC/OH, and TRAIN/OH, the statistics did not definitely

TABLE 4
RANKED BY INDEPENDENT VARIABLE X (8)

ORDER NO.	X (8)	X (9)	X (10)	X (11)	X (12)	DIGITAL	ANALOG	EM	PS	XTMR	SS	POWDS	UFAC	BITFIT	DEP. VAR.	MTRMA
19	153.	85.	2.68	78.	0.91	0.28	100.28	0.28	0.28	0.28	0.28	17.	1.38	0.28	0.	0.
20	158.	3.	1.28	38.	1.27	0.28	127.28	0.28	0.28	0.28	0.28	34.	1.38	0.28	3724.	3724.
21	168.	22.	8.58	9.	0.04	0.28	127.28	0.28	0.28	0.28	0.28	120.	1.38	0.28	7538.	7538.
51	815.	22.	8.58	9.	0.04	0.28	127.28	0.28	0.28	0.28	0.28	120.	1.38	0.28	6878.	6878.
52	815.	22.	8.58	9.	0.04	0.28	127.28	0.28	0.28	0.28	0.28	120.	1.38	0.28	2821.	2821.
7	848.	24.	7.58	12.	0.13	0.28	127.28	0.28	0.28	0.28	0.28	22.	1.38	0.28	1829.	1829.
15	1158.	29.	7.58	214.	0.23	0.28	127.28	0.28	0.28	0.28	0.28	22.	1.38	0.28	1367.	1367.
38	1258.	29.	7.58	214.	0.23	0.28	127.28	0.28	0.28	0.28	0.28	22.	1.38	0.28	1367.	1367.
25	1347.	13.	7.43	120.	0.01	0.28	127.28	0.28	0.28	0.28	0.28	34.	1.38	0.28	649.	649.
38	1622.	308.	14.28	358.	0.82	0.28	127.28	0.28	0.28	0.28	0.28	869.	1.22	0.28	272.	272.
29	2831.	4243.	62.38	4353.	1.83	0.28	127.28	0.28	0.28	0.28	0.28	169.	1.22	0.28	330.	330.
33	2045.	133.	1.25	84.	0.63	0.28	127.28	0.28	0.28	0.28	0.28	87.	1.22	0.28	3542.	3542.
33	2185.	368.	0.28	88.	0.24	0.28	127.28	0.28	0.28	0.28	0.28	87.	1.22	0.28	1466.	1466.
6	2241.	1276.	36.54	756.	0.59	0.28	127.28	0.28	0.28	0.28	0.28	289.	1.22	0.28	476.	476.
25	2598.	464.	11.58	177.	0.38	0.28	127.28	0.28	0.28	0.28	0.28	132.	1.22	0.28	113.	113.
44	2632.	567.	15.08	911.	1.63	0.28	127.28	0.28	0.28	0.28	0.28	335.	1.22	0.28	582.	582.
17	2744.	1732.	60.28	924.	0.53	0.28	127.28	0.28	0.28	0.28	0.28	17.	1.22	0.28	98.	98.
37	2745.	1734.	60.28	924.	0.53	0.28	127.28	0.28	0.28	0.28	0.28	17.	1.22	0.28	124.	124.
21	2745.	256.	12.58	29.	0.27	0.28	127.28	0.28	0.28	0.28	0.28	189.	1.22	0.28	1781.	1781.
48	3015.	94.	4.22	128.	1.15	0.28	127.28	0.28	0.28	0.28	0.28	7.	1.22	0.28	1379.	1379.
27	3265.	1734.	60.28	924.	0.53	0.28	127.28	0.28	0.28	0.28	0.28	189.	1.22	0.28	1781.	1781.
29	3778.	6778.	87.58	321.	0.25	0.28	127.28	0.28	0.28	0.28	0.28	189.	1.22	0.28	1379.	1379.
61	3845.	144.	40.28	1153.	0.69	0.28	127.28	0.28	0.28	0.28	0.28	582.	1.22	0.28	51.	51.
67	3845.	144.	40.28	1153.	0.69	0.28	127.28	0.28	0.28	0.28	0.28	582.	1.22	0.28	78.	78.
64	3914.	1844.	20.28	1236.	0.67	0.28	127.28	0.28	0.28	0.28	0.28	582.	1.22	0.28	118.	118.
62	3914.	1844.	20.28	1236.	0.67	0.28	127.28	0.28	0.28	0.28	0.28	582.	1.22	0.28	189.	189.
65	4043.	1844.	20.28	1236.	0.67	0.28	127.28	0.28	0.28	0.28	0.28	582.	1.22	0.28	289.	289.
68	4228.	242.	0.28	1615.	0.67	0.28	127.28	0.28	0.28	0.28	0.28	582.	1.22	0.28	582.	582.
24	5722.	3569.	58.28	158.	0.05	0.28	127.28	0.28	0.28	0.28	0.28	35.	1.22	0.28	342.	342.
63	5852.	1849.	40.28	1371.	0.74	0.28	127.28	0.28	0.28	0.28	0.28	35.	1.22	0.28	223.	223.
19	5852.	1849.	40.28	1371.	0.74	0.28	127.28	0.28	0.28	0.28	0.28	35.	1.22	0.28	173.	173.
37	5852.	1849.	40.28	1371.	0.74	0.28	127.28	0.28	0.28	0.28	0.28	35.	1.22	0.28	173.	173.
3	5852.	1849.	40.28	1371.	0.74	0.28	127.28	0.28	0.28	0.28	0.28	35.	1.22	0.28	173.	173.
59	5852.	1849.	40.28	1371.	0.74	0.28	127.28	0.28	0.28	0.28	0.28	35.	1.22	0.28	173.	173.
56	7191.	1367.	36.28	1674.	1.22	0.28	127.28	0.28	0.28	0.28	0.28	212.	1.22	0.28	280.	280.
5	8419.	1473.	40.28	1689.	0.47	0.28	127.28	0.28	0.28	0.28	0.28	212.	1.22	0.28	161.	161.
12	8439.	220.	5.58	158.	0.75	0.28	127.28	0.28	0.28	0.28	0.28	212.	1.22	0.28	78.	78.
58	9741.	1767.	45.28	946.	0.54	0.28	127.28	0.28	0.28	0.28	0.28	212.	1.22	0.28	133.	133.
58	9741.	1767.	45.28	946.	0.54	0.28	127.28	0.28	0.28	0.28	0.28	212.	1.22	0.28	133.	133.
41	12040.	142.	13.08	412.	2.98	0.28	127.28	0.28	0.28	0.28	0.28	212.	1.22	0.28	346.	346.
65	12712.	1127.	41.08	798.	0.71	0.28	127.28	0.28	0.28	0.28	0.28	212.	1.22	0.28	133.	133.
1	13721.	443.	17.78	418.	0.93	0.28	127.28	0.28	0.28	0.28	0.28	212.	1.22	0.28	133.	133.
59	14371.	377.	14.28	982.	0.68	0.28	127.28	0.28	0.28	0.28	0.28	212.	1.22	0.28	133.	133.
42	15258.	1377.	78.58	309.	0.29	0.28	127.28	0.28	0.28	0.28	0.28	212.	1.22	0.28	133.	133.
35	16733.	412.	31.28	592.	1.37	0.28	127.28	0.28	0.28	0.28	0.28	212.	1.22	0.28	133.	133.
11	16620.	424.	11.28	61.	0.14	0.28	127.28	0.28	0.28	0.28	0.28	212.	1.22	0.28	133.	133.
22	18724.	820.	118.28	561.	0.26	0.28	127.28	0.28	0.28	0.28	0.28	212.	1.22	0.28	133.	133.
45	19274.	551.	25.28	1319.	0.72	0.28	127.28	0.28	0.28	0.28	0.28	212.	1.22	0.28	133.	133.
9	21377.	584.	14.28	529.	1.72	0.28	127.28	0.28	0.28	0.28	0.28	212.	1.22	0.28	133.	133.
54	24422.	377.	18.08	529.	1.72	0.28	127.28	0.28	0.28	0.28	0.28	212.	1.22	0.28	133.	133.
52	31645.	1223.	25.28	1557.	1.10	0.28	127.28	0.28	0.28	0.28	0.28	212.	1.22	0.28	133.	133.
33	36462.	1276.	30.68	273.	2.18	0.28	127.28	0.28	0.28	0.28	0.28	212.	1.22	0.28	133.	133.
4	41334.	984.	16.68	276.	2.18	0.28	127.28	0.28	0.28	0.28	0.28	212.	1.22	0.28	133.	133.
55	43312.	577.	12.28	53.	0.26	0.28	127.28	0.28	0.28	0.28	0.28	212.	1.22	0.28	133.	133.
48	46750.	1846.	35.28	932.	0.54	0.28	127.28	0.28	0.28	0.28	0.28	212.	1.22	0.28	133.	133.
13	57120.	866.	29.28	32.	0.74	0.28	127.28	0.28	0.28	0.28	0.28	212.	1.22	0.28	133.	133.
34	104530.	1511.	39.68	1644.	0.69	0.28	127.28	0.28	0.28	0.28	0.28	212.	1.22	0.28	133.	133.
46	238730.	2278.	41.88	7638.	3.35	0.28	127.28	0.28	0.28	0.28	0.28	212.	1.22	0.28	133.	133.
31	324920.	2475.	75.88	4895.	1.82	0.28	127.28	0.28	0.28	0.28	0.28	212.	1.22	0.28	133.	133.
49	324920.	3656.	118.28	18.	0.22	0.28	127.28	0.28	0.28	0.28	0.28	212.	1.22	0.28	133.	133.

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

Q&M MODEL PASS 3 DEP VAR 11 Y3 MIN Y = 4.5500 P1 MAX Y = 7.5300 P3 RANGE Y = 7.4840 P3

IND. VAR(I)	NAME	COEF. R(I)	S.E. COEF.	T-VALUE	R(I) SQD	MIN X(I)	MAX X(I)	RANGE X(I)	REL. INF. X(I)
1	X1M	-4.29000 P3	0.290 P2	1.9	0.7650	-2.7400-P1	7.2600-P1	1.0000 P0	0.16
2	X2M	1.165540 P3	7.480 P2	0.7	0.5338	-2.7400-P1	7.2600-P1	1.0000 P0	0.07
3	X3M	5.475220 P2	4.800 P2	1.0	0.5829	-2.5800-P1	7.4200-P1	1.0000 P0	0.11
4	X4M	7.871970 P2	4.920 P2	0.7	0.5286	-2.1800-P1	7.9800-P1	1.0000 P0	0.04
5	X5	-3.180210 P2	8.790 P2	3.0	0.3464	-2.0300-P1	5.3970-P1	7.4200 P0	0.26
6	X6	2.646900 P3	9.320 P2	0.3	0.3871	-2.1850-P1	5.7350-P1	7.9800-P1	0.00
7	X7	3.923750 P1	6.960 P2	0.3	0.4212	-2.1850-P1	5.7350-P1	7.9800-P1	0.03
8	X8	-2.974560 P2	4.160-P3	0.0	0.7129	1.5800 P2	3.2400 P5	3.2400 P5	0.14
9	X9	3.278670-P3	2.200-P1	1.1	0.8540	3.4000 P1	8.2070 P3	8.1700 P3	0.27
10	X10	2.472110-P1	1.520 P1	2.4	0.9198	1.2900 P0	1.7370 P2	1.7250 P2	0.03
11	X11	-3.58770 P1	1.860-P1	0.8	0.5498	0.9800 P4	7.6300 P3	7.6200 P3	0.15
12	X12	-1.457700-P1	1.900 P2	0.2	0.5792	4.9200-P3	6.6740 P4	6.6600 P0	0.74
13	X13	6.323970 P1	1.420 P2	0.4	0.5982	0.0	1.8000 P2	1.8000 P2	0.84
14	X14	5.839790 P1	1.380 P2	0.4	0.5993	0.0	1.8000 P2	1.8000 P2	0.78
15	X15	6.577430 P1	1.390 P2	0.5	0.5991	0.0	1.8000 P2	1.8000 P2	0.88
16	X16	5.439250 P1	1.390 P2	0.4	0.5969	0.0	1.8000 P2	1.8000 P2	0.73
17	X17	8.023820 P1	1.360 P2	0.6	0.5975	0.0	1.8000 P2	1.8000 P2	1.07
18	X18	-6.856420 P0	5.580 P0	1.2	0.5389	0.0	1.8000 P2	1.8000 P2	0.09
19	X19	-5.165290-P1	5.010-P1	1.0	0.5659	7.8900 P0	1.6400 P3	1.6330 P3	0.11
20	X20	2.228460 P2	5.920 P2	0.4	0.8297	3.8800-P1	2.3800 P0	2.8800 P0	0.06
21	X21	1.736950 P1	1.680 P1	1.0	0.5878	0.0	6.1900 P1	6.1900 P1	0.14

NO. OF OBSERVATIONS 62
 NO. OF IND. VARIABLES 21
 RESIDUAL DEGREES OF FREEDOM 40
 F-VALUE 3.1
 RESIDUAL ROOT MEAN SQUARE 1871.42220661
 RESIDUAL MEAN SQUARE 1147945.54481195
 RESIDUAL SUM OF SQUARES *****
 TOTAL SUM OF SQUARES 121154112.61884688
 MULT. CORREL. COEF. SQUARED .6210

REQUIRED X(I) PRECISION
 (DIGIT RIGHT OF DECIMAL POSITIVE,
 LEFT OF DECIMAL NEGATIVE)

IND. VAR(I)	DIGIT
1	1
2	1
3	1
4	1
5	1
6	1
7	1
8	-5
9	-4
10	-4
11	1
12	1
13	1
14	1
15	1
16	1
17	1
18	-2
19	-3
20	1
21	-2

FIGURE 23

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL PASS 3 DEP VAR 11 Y3			ORDERED BY COMPUTEN INPUT			ORDERED BY RESIDUALS		
IDENT.	OBSV.	WSS DISTANCE	ORIG. Y	FITTED Y	RESIDUAL	OBSV.	ORIG. Y	FITTED Y
71922	1	3	163.328	445.671	-282.343	8	3539.792	884.357
71923	2	3	173.728	-54.535	228.263	51	7529.402	2554.375
71924	3	2	203.728	739.319	-539.512	28	3783.738	1821.117
71925	4	3	191.628	1824.125	-934.497	53	6878.388	5925.225
71926	5	19	133.428	313.513	-180.085	7	2528.888	815.326
71927	6	3	476.122	-16.334	492.456	31	72.222	-832.499
71928	7	8	2502.822	815.326	1787.496	45	151.422	-433.651
71929	8	7	3539.792	884.357	2655.435	63	172.922	-555.095
71930	9	4	34.338	1228.581	-1194.243	47	178.198	-532.558
71931	10	9	528.588	724.416	-195.828	48	1398.788	819.725
71932	11	14	736.588	1755.639	-1019.051	46	476.122	-15.234
71933	12	3	213.522	1133.882	-920.360	35	284.428	-159.326
71934	13	6	995.728	1087.886	-92.158	22	453.588	-382.238
71935	14	6	995.728	1087.886	-92.158	18	128.588	-253.872
71936	15	6	995.728	1087.886	-92.158	29	384.988	-4.824
71937	16	8	128.588	-253.872	374.460	2	273.722	-54.575
71938	17	9	128.588	-253.872	374.460	36	1387.722	1959.735
71939	18	9	3783.738	1821.117	-1962.621	57	119.622	-113.388
71940	19	41	1781.622	2255.882	-474.260	40	195.588	-16.594
71941	20	18	45.522	-342.822	388.344	66	139.222	-61.715
71942	21	9	232.722	815.326	-582.604	21	139.222	-61.715
71943	22	18	648.722	1117.731	-469.009	22	139.222	-61.715
71944	23	9	113.122	1217.731	-1104.609	23	139.222	-61.715
71945	24	4	63.522	422.288	-358.766	24	139.222	-61.715
71946	25	8	335.222	-58.101	393.323	25	139.222	-61.715
71947	26	6	335.222	-58.101	393.323	26	139.222	-61.715
71948	27	6	335.222	-58.101	393.323	27	139.222	-61.715
71949	28	6	335.222	-58.101	393.323	28	139.222	-61.715
71950	29	6	335.222	-58.101	393.323	29	139.222	-61.715
71951	30	6	335.222	-58.101	393.323	30	139.222	-61.715
71952	31	6	335.222	-58.101	393.323	31	139.222	-61.715
71953	32	6	335.222	-58.101	393.323	32	139.222	-61.715
71954	33	6	335.222	-58.101	393.323	33	139.222	-61.715
71955	34	6	335.222	-58.101	393.323	34	139.222	-61.715
71956	35	6	335.222	-58.101	393.323	35	139.222	-61.715
71957	36	6	335.222	-58.101	393.323	36	139.222	-61.715
71958	37	6	335.222	-58.101	393.323	37	139.222	-61.715
71959	38	6	335.222	-58.101	393.323	38	139.222	-61.715
71960	39	6	335.222	-58.101	393.323	39	139.222	-61.715
71961	40	6	335.222	-58.101	393.323	40	139.222	-61.715
71962	41	6	335.222	-58.101	393.323	41	139.222	-61.715
71963	42	6	335.222	-58.101	393.323	42	139.222	-61.715
71964	43	6	335.222	-58.101	393.323	43	139.222	-61.715
71965	44	6	335.222	-58.101	393.323	44	139.222	-61.715
71966	45	6	335.222	-58.101	393.323	45	139.222	-61.715
71967	46	6	335.222	-58.101	393.323	46	139.222	-61.715
71968	47	6	335.222	-58.101	393.323	47	139.222	-61.715
71969	48	6	335.222	-58.101	393.323	48	139.222	-61.715
71970	49	6	335.222	-58.101	393.323	49	139.222	-61.715
71971	50	6	335.222	-58.101	393.323	50	139.222	-61.715
71972	51	6	335.222	-58.101	393.323	51	139.222	-61.715
71973	52	6	335.222	-58.101	393.323	52	139.222	-61.715
71974	53	6	335.222	-58.101	393.323	53	139.222	-61.715
71975	54	6	335.222	-58.101	393.323	54	139.222	-61.715
71976	55	6	335.222	-58.101	393.323	55	139.222	-61.715
71977	56	6	335.222	-58.101	393.323	56	139.222	-61.715
71978	57	6	335.222	-58.101	393.323	57	139.222	-61.715
71979	58	6	335.222	-58.101	393.323	58	139.222	-61.715
71980	59	6	335.222	-58.101	393.323	59	139.222	-61.715
71981	60	6	335.222	-58.101	393.323	60	139.222	-61.715
71982	61	6	335.222	-58.101	393.323	61	139.222	-61.715
71983	62	6	335.222	-58.101	393.323	62	139.222	-61.715
71984	63	6	335.222	-58.101	393.323	63	139.222	-61.715
71985	64	6	335.222	-58.101	393.323	64	139.222	-61.715
71986	65	6	335.222	-58.101	393.323	65	139.222	-61.715
71987	66	6	335.222	-58.101	393.323	66	139.222	-61.715
71988	67	6	335.222	-58.101	393.323	67	139.222	-61.715
71989	68	6	335.222	-58.101	393.323	68	139.222	-61.715
71990	69	6	335.222	-58.101	393.323	69	139.222	-61.715
71991	70	6	335.222	-58.101	393.323	70	139.222	-61.715
71992	71	6	335.222	-58.101	393.323	71	139.222	-61.715
71993	72	6	335.222	-58.101	393.323	72	139.222	-61.715
71994	73	6	335.222	-58.101	393.323	73	139.222	-61.715
71995	74	6	335.222	-58.101	393.323	74	139.222	-61.715
71996	75	6	335.222	-58.101	393.323	75	139.222	-61.715
71997	76	6	335.222	-58.101	393.323	76	139.222	-61.715
71998	77	6	335.222	-58.101	393.323	77	139.222	-61.715
71999	78	6	335.222	-58.101	393.323	78	139.222	-61.715
72000	79	6	335.222	-58.101	393.323	79	139.222	-61.715
72001	80	6	335.222	-58.101	393.323	80	139.222	-61.715
72002	81	6	335.222	-58.101	393.323	81	139.222	-61.715
72003	82	6	335.222	-58.101	393.323	82	139.222	-61.715
72004	83	6	335.222	-58.101	393.323	83	139.222	-61.715
72005	84	6	335.222	-58.101	393.323	84	139.222	-61.715
72006	85	6	335.222	-58.101	393.323	85	139.222	-61.715
72007	86	6	335.222	-58.101	393.323	86	139.222	-61.715
72008	87	6	335.222	-58.101	393.323	87	139.222	-61.715
72009	88	6	335.222	-58.101	393.323	88	139.222	-61.715
72010	89	6	335.222	-58.101	393.323	89	139.222	-61.715
72011	90	6	335.222	-58.101	393.323	90	139.222	-61.715
72012	91	6	335.222	-58.101	393.323	91	139.222	-61.715
72013	92	6	335.222	-58.101	393.323	92	139.222	-61.715
72014	93	6	335.222	-58.101	393.323	93	139.222	-61.715
72015	94	6	335.222	-58.101	393.323	94	139.222	-61.715
72016	95	6	335.222	-58.101	393.323	95	139.222	-61.715
72017	96	6	335.222	-58.101	393.323	96	139.222	-61.715
72018	97	6	335.222	-58.101	393.323	97	139.222	-61.715
72019	98	6	335.222	-58.101	393.323	98	139.222	-61.715
72020	99	6	335.222	-58.101	393.323	99	139.222	-61.715
72021	100	6	335.222	-58.101	393.323	100	139.222	-61.715

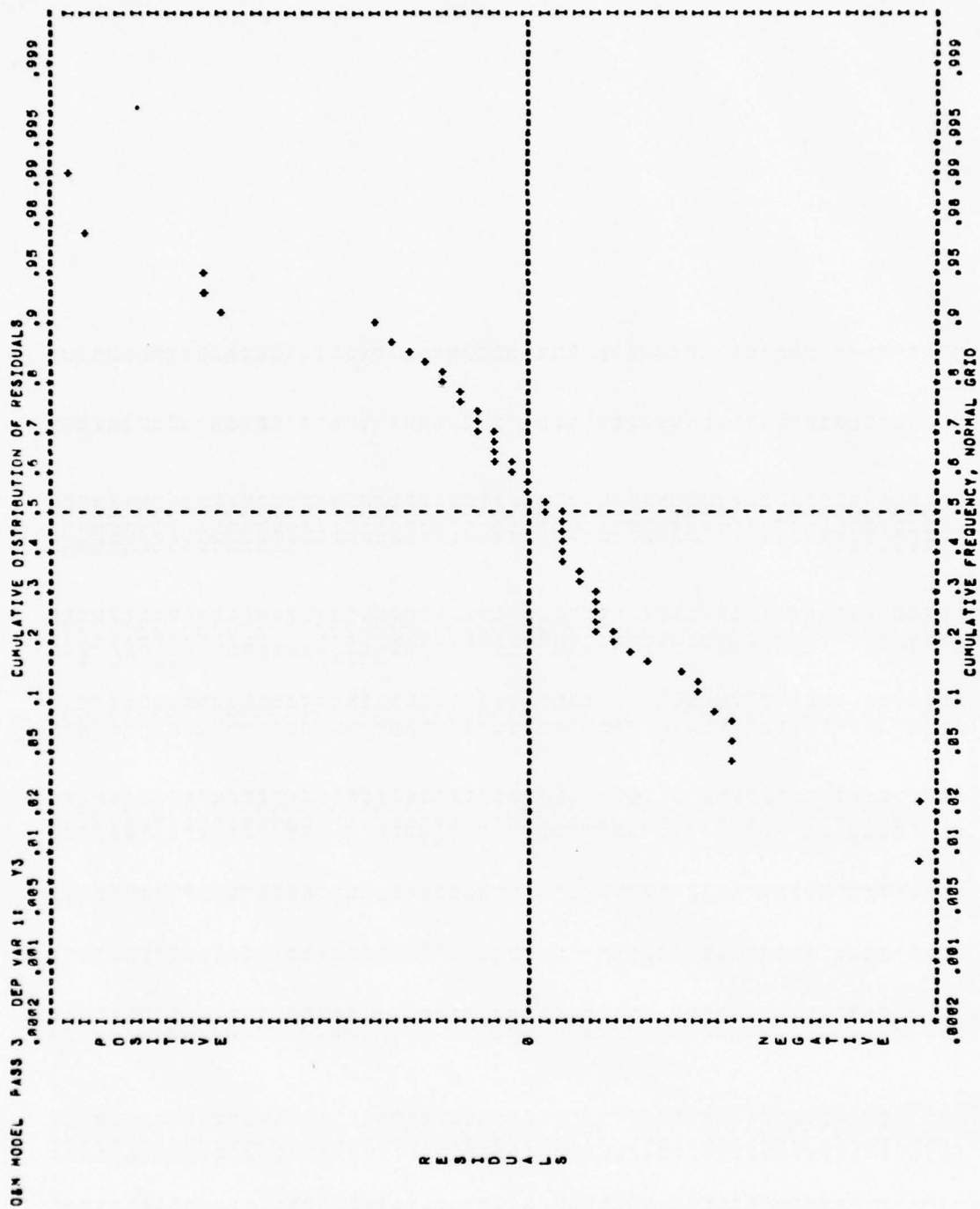


FIGURE 26

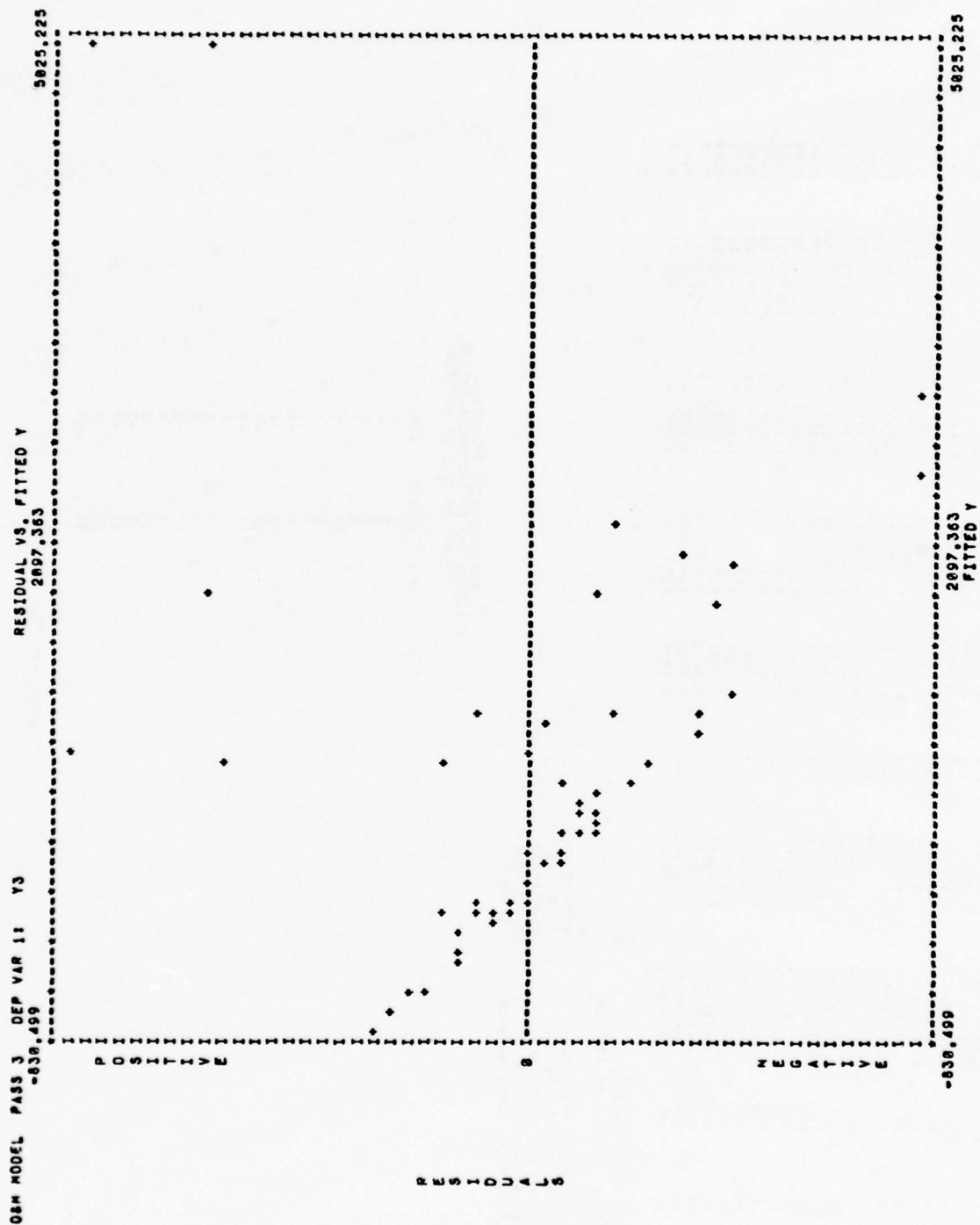


FIGURE 27

QEM MODEL PASS 3 DEP VAR 21 LNYS

MIN Y = 3.818D PP MAX Y = 8.927D 00 RANGE Y = 5.109D 00

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

INO.VAR(I)	NAME	COEF. R(I)	S.E. COEF.	T-VALUE	R(I)SQRD	MIN X(I)	MAX X(I)	RANGE X(I)	REL. INF. X(I)
0		4.57627D 00							
1	X1H	6.20354D -01	4.69D -01	1.3	0.7638	-2.74D -01	7.26D -01	1.02D 00	0.12
2	X2H	5.4127D -01	5.57D -01	1.0	0.6338	-2.74D -01	7.26D -01	1.02D 00	0.11
3	X3H	6.2323D -01	3.58D -01	1.7	0.5809	-2.56D -01	7.42D -01	1.02D 00	0.12
4	X4H	-2.3358D -01	3.29D -01	2.2	0.4266	-2.12D -01	7.90D -01	1.02D 00	0.14
5	X5	8.1558D -01	6.54D -01	1.2	0.3454	-2.03D -01	5.38D -01	7.42D -01	0.12
6	X6	1.4824D -01	6.94D -01	0.2	0.3871	-2.16D -01	5.73D -01	7.90D -01	0.02
7	X7	-1.1858D -01	6.67D -01	0.5	0.4812	-2.16D -01	5.73D -01	7.90D -01	0.05
8	X8	2.2842D -01	3.10D -01	0.7	0.7159	1.58D 02	3.23D 05	3.23D 05	0.15
9	X9	2.3799D -01	1.64D -01	1.5	0.6540	3.84D 01	8.17D 03	8.17D 03	0.38
10	X10	-3.6755D -02	1.13D -02	3.3	0.9192	1.22D 02	1.73D 02	1.73D 02	1.24
11	X11	-1.7842D -01	1.39D -01	1.2	0.6498	9.82D 00	7.62D 03	7.62D 03	0.25
12	X12	1.0497D -01	1.48D -01	0.7	0.5792	4.92D -03	6.67D 03	6.67D 03	0.14
13	X13	1.2818D -02	1.86D -01	0.1	0.9942	0.0	1.02D 02	1.02D 02	0.24
14	X14	1.9231D -02	1.82D -01	0.2	0.9903	0.0	1.02D 02	1.02D 02	0.38
15	X15	2.8678D -02	1.84D -01	0.3	0.9991	0.0	1.02D 02	1.02D 02	0.56
16	X16	1.1668D -02	1.83D -01	0.1	0.9969	0.0	1.02D 02	1.02D 02	0.23
17	X17	2.9847D -02	1.83D -01	0.3	0.9975	0.0	1.02D 02	1.02D 02	0.38
18	X18	1.1246D -03	4.14D -03	0.3	0.6589	0.0	1.02D 02	1.02D 02	0.02
19	X19	-4.8124D -04	3.73D -04	1.3	0.6589	7.88D 00	1.53D 03	1.53D 03	0.15
20	X20	-1.4565D -02	4.41D -01	0.0	0.6297	3.80D -01	2.38D 00	2.38D 00	0.01
21	X21	2.1328D -02	1.25D -02	1.7	0.5878	0.0	6.18D 01	6.18D 01	0.25

NO. OF OBSERVATIONS 62

NO. OF INO. VARIABLES 21

RESIDUAL DEGREES OF FREEDOM 40

F-VALUE 4.9

RESIDUAL ROOT MEAN SQUARE 0.79782443

RESIDUAL MEAN SQUARE 0.63649191

TOTAL SUM OF SQUARES 25.45987858

TOTAL SUM OF SQUARES 99.47129248

MULT. CORREL. COEF. SQUARED .7186

REQUIRED X(I) PRECISION
(OIGIT RIGHT OF DECIMAL POSITIVE,
LEFT OF DECIMAL NEGATIVE)

INO.VAR(I)	OIGIT
1	1
2	1
3	1
4	1
5	1
6	1
7	1
8	-5
9	-4
10	-2
11	-4
12	1
13	1
14	1
15	1
16	1
17	1
18	-2
19	-3
20	1
21	-2

FIGURE 28

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

DATA MODEL PASS 3 DEP VAR 21 LMS

IDENT.	OBSV.	ORDERED BY COMPUTER INPUT	RESIDUAL	OBSV.	ORDERED BY RESIDUALS	FITTED Y	ORDERED RESID.	SEQ
7820	1	5.833	-0.737	8	6.172	6.326	1.846	1
7821	2	5.996	-0.737	9	6.172	6.326	1.846	2
7822	3	5.612	-0.245	10	6.217	6.221	1.632	3
7823	4	5.218	-0.137	11	6.217	6.221	1.476	4
7824	5	5.881	-0.1095	12	5.799	4.784	1.814	5
7825	6	4.784	-0.467	13	5.156	5.156	1.929	6
7826	7	5.381	-0.467	14	5.156	5.156	1.929	7
7827	8	5.156	1.093	15	5.881	5.881	1.758	8
7828	9	6.221	1.093	16	4.457	4.457	0.715	9
7829	10	6.326	1.846	17	4.784	4.784	0.519	10
7830	11	6.221	-1.359	18	6.217	6.217	0.502	11
7831	12	5.944	-0.307	19	6.217	6.217	0.502	12
7832	13	6.786	-0.168	20	7.177	6.663	0.494	13
7833	14	6.144	-0.168	21	5.881	4.663	0.418	14
7834	15	6.947	-0.779	22	6.836	6.836	0.411	15
7835	16	6.672	-0.236	23	7.235	8.423	0.396	16
7836	17	4.686	-0.178	24	5.276	6.836	0.378	17
7837	18	4.588	-0.178	25	4.343	4.343	0.361	18
7838	19	4.795	1.476	26	5.276	4.343	0.361	19
7839	20	6.741	0.331	27	7.485	7.485	0.331	20
7840	21	7.485	-0.597	28	5.881	5.881	0.316	21
7841	22	4.415	-0.597	29	6.217	6.217	0.307	22
7842	23	5.595	-0.145	30	5.881	5.881	0.295	23
7843	24	5.458	-0.145	31	5.881	5.881	0.249	24
7844	25	6.475	-0.173	32	5.881	5.881	0.249	25
7845	26	4.728	-1.537	33	5.881	5.881	0.249	26
7846	27	4.283	-0.784	34	5.881	5.881	0.249	27
7847	28	4.947	-0.295	35	5.881	5.881	0.249	28
7848	29	4.892	1.014	36	4.784	4.784	0.176	29
7849	30	4.277	-0.823	37	4.784	4.784	0.176	30
7850	31	4.388	-0.823	38	4.784	4.784	0.176	31
7851	32	5.697	-0.890	39	5.552	5.552	0.044	32
7852	33	5.491	-2.411	40	5.552	5.552	0.044	33
7853	34	5.845	-0.198	41	4.772	4.772	0.026	34
7854	35	5.654	-0.824	42	4.772	4.772	0.026	35
7855	36	6.836	-0.396	43	7.177	7.177	0.027	36
7856	37	4.945	-0.298	44	5.528	5.528	0.042	37
7857	38	5.607	0.316	45	5.881	5.881	0.042	38
7858	39	7.384	0.307	46	5.881	5.881	0.042	39
7859	40	6.836	0.494	47	5.881	5.881	0.042	40
7860	41	4.848	-0.761	48	5.881	5.881	0.042	41
7861	42	4.795	-0.808	49	5.881	5.881	0.042	42
7862	43	7.177	-0.827	50	4.822	4.822	0.134	43
7863	44	5.945	-0.327	51	5.552	5.552	0.145	44
7864	45	6.272	-0.418	52	5.552	5.552	0.145	45
7865	46	4.666	-0.418	53	6.081	6.081	0.165	46
7866	47	5.823	-0.418	54	6.081	6.081	0.165	47
7867	48	5.925	-0.750	55	6.756	6.756	0.173	48
7868	49	5.581	-0.306	56	4.846	4.846	0.198	49
7869	50	4.808	-0.378	57	4.846	4.846	0.198	50
7870	51	6.382	-0.536	58	4.846	4.846	0.198	51
7871	52	4.425	-0.536	59	4.846	4.846	0.198	52
7872	53	7.187	-0.377	60	4.846	4.846	0.198	53
7873	54	8.425	-0.411	61	5.276	5.276	0.208	54
7874	55	6.836	-0.000	62	5.276	5.276	0.208	55
7875	56	7.385	-0.569	63	6.738	7.107	0.327	56
7876	57	4.359	-0.249	64	5.881	5.881	0.377	57
7877	58	4.784	-0.176	65	4.113	4.113	0.411	58
7878	59	4.942	-0.134	66	4.113	4.113	0.411	59
7879	60	5.566	-0.212	67	5.846	5.846	0.459	60
7880	61	4.571	-0.459	68	6.318	6.318	0.459	61
7881	62	4.571	-0.459	69	6.318	6.318	0.459	62
7882	63	5.528	-0.215	70	4.415	4.415	0.536	63
7883	64	5.528	-0.215	71	4.415	4.415	0.536	64
7884	65	4.437	-0.642	72	5.276	5.276	0.704	65
7885	66	5.153	-0.715	73	4.846	4.846	0.737	66
7886	67	5.245	-0.899	74	5.276	5.276	0.761	67
7887	68	4.611	-0.255	75	4.846	4.846	0.779	68
7888	69	4.836	-0.255	76	4.846	4.846	0.805	69
7889	70	4.333	-0.361	77	4.784	4.784	0.888	70
7890	71	5.932	-0.118	78	4.784	4.784	0.888	71
7891	72	5.932	-0.118	79	4.784	4.784	0.888	72

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM									
QRM MODEL	PASS 3	DEP VAR 2: LNY3	RESIDUAL ROOT MEAN SQUARE OF FITTED EQUATIONS				0.80		
STANDARD DEVIATION ESTIMATED FROM RESIDUALS OF NEIGHBORING OBSERVATIONS (OBSERVATIONS 1 TO 4 APART IN FITTED Y ORDER).									
NO.	CUMULATIVE STD DEV	ORDERED BY OBSV.	MSD	DEL RESIDUALS	ORDERED BY OBSV.	MSD	DEL RESIDUALS	FITTED Y	SEQ.
1	0.12	51	0.3	0.09	51	49.13	1.01	3.92	1
2	0.24	57	0.3	0.42	57	7.82	0.77	4.27	2
3	0.24	51	0.3	0.24	51	5.84	0.54	4.28	3
4	0.32	37	0.3	0.41	37	4.50	0.36	4.36	4
5	0.38	65	0.3	0.62	65	15.38	0.96	4.34	5
6	0.38	65	0.3	0.62	65	15.38	0.96	4.34	6
7	0.39	29	0.3	1.03	29	1.53	1.51	4.41	7
8	0.39	29	0.3	1.03	29	1.53	1.51	4.41	8
9	0.39	43	0.3	0.21	43	7.54	0.24	4.57	9
10	0.39	43	0.3	0.21	43	7.54	0.24	4.57	10
11	0.39	43	0.3	0.21	43	7.54	0.24	4.57	11
12	0.39	43	0.3	0.21	43	7.54	0.24	4.57	12
13	0.39	43	0.3	0.21	43	7.54	0.24	4.57	13
14	0.39	43	0.3	0.21	43	7.54	0.24	4.57	14
15	0.39	43	0.3	0.21	43	7.54	0.24	4.57	15
16	0.39	43	0.3	0.21	43	7.54	0.24	4.57	16
17	0.39	43	0.3	0.21	43	7.54	0.24	4.57	17
18	0.39	43	0.3	0.21	43	7.54	0.24	4.57	18
19	0.39	43	0.3	0.21	43	7.54	0.24	4.57	19
20	0.39	43	0.3	0.21	43	7.54	0.24	4.57	20
21	0.39	43	0.3	0.21	43	7.54	0.24	4.57	21
22	0.39	43	0.3	0.21	43	7.54	0.24	4.57	22
23	0.39	43	0.3	0.21	43	7.54	0.24	4.57	23
24	0.39	43	0.3	0.21	43	7.54	0.24	4.57	24
25	0.39	43	0.3	0.21	43	7.54	0.24	4.57	25
26	0.39	43	0.3	0.21	43	7.54	0.24	4.57	26
27	0.39	43	0.3	0.21	43	7.54	0.24	4.57	27
28	0.39	43	0.3	0.21	43	7.54	0.24	4.57	28
29	0.39	43	0.3	0.21	43	7.54	0.24	4.57	29
30	0.39	43	0.3	0.21	43	7.54	0.24	4.57	30
31	0.39	43	0.3	0.21	43	7.54	0.24	4.57	31
32	0.39	43	0.3	0.21	43	7.54	0.24	4.57	32
33	0.39	43	0.3	0.21	43	7.54	0.24	4.57	33
34	0.39	43	0.3	0.21	43	7.54	0.24	4.57	34
35	0.39	43	0.3	0.21	43	7.54	0.24	4.57	35
36	0.39	43	0.3	0.21	43	7.54	0.24	4.57	36
37	0.39	43	0.3	0.21	43	7.54	0.24	4.57	37
38	0.39	43	0.3	0.21	43	7.54	0.24	4.57	38
39	0.39	43	0.3	0.21	43	7.54	0.24	4.57	39
40	0.39	43	0.3	0.21	43	7.54	0.24	4.57	40
41	0.39	43	0.3	0.21	43	7.54	0.24	4.57	41
42	0.39	43	0.3	0.21	43	7.54	0.24	4.57	42
43	0.39	43	0.3	0.21	43	7.54	0.24	4.57	43
44	0.39	43	0.3	0.21	43	7.54	0.24	4.57	44
45	0.39	43	0.3	0.21	43	7.54	0.24	4.57	45
46	0.39	43	0.3	0.21	43	7.54	0.24	4.57	46
47	0.39	43	0.3	0.21	43	7.54	0.24	4.57	47
48	0.39	43	0.3	0.21	43	7.54	0.24	4.57	48
49	0.39	43	0.3	0.21	43	7.54	0.24	4.57	49
50	0.39	43	0.3	0.21	43	7.54	0.24	4.57	50
51	0.39	43	0.3	0.21	43	7.54	0.24	4.57	51
52	0.39	43	0.3	0.21	43	7.54	0.24	4.57	52
53	0.39	43	0.3	0.21	43	7.54	0.24	4.57	53
54	0.39	43	0.3	0.21	43	7.54	0.24	4.57	54
55	0.39	43	0.3	0.21	43	7.54	0.24	4.57	55
56	0.39	43	0.3	0.21	43	7.54	0.24	4.57	56
57	0.39	43	0.3	0.21	43	7.54	0.24	4.57	57
58	0.39	43	0.3	0.21	43	7.54	0.24	4.57	58
59	0.39	43	0.3	0.21	43	7.54	0.24	4.57	59
60	0.39	43	0.3	0.21	43	7.54	0.24	4.57	60
61	0.39	43	0.3	0.21	43	7.54	0.24	4.57	61
62	0.39	43	0.3	0.21	43	7.54	0.24	4.57	62

FIGURE 30

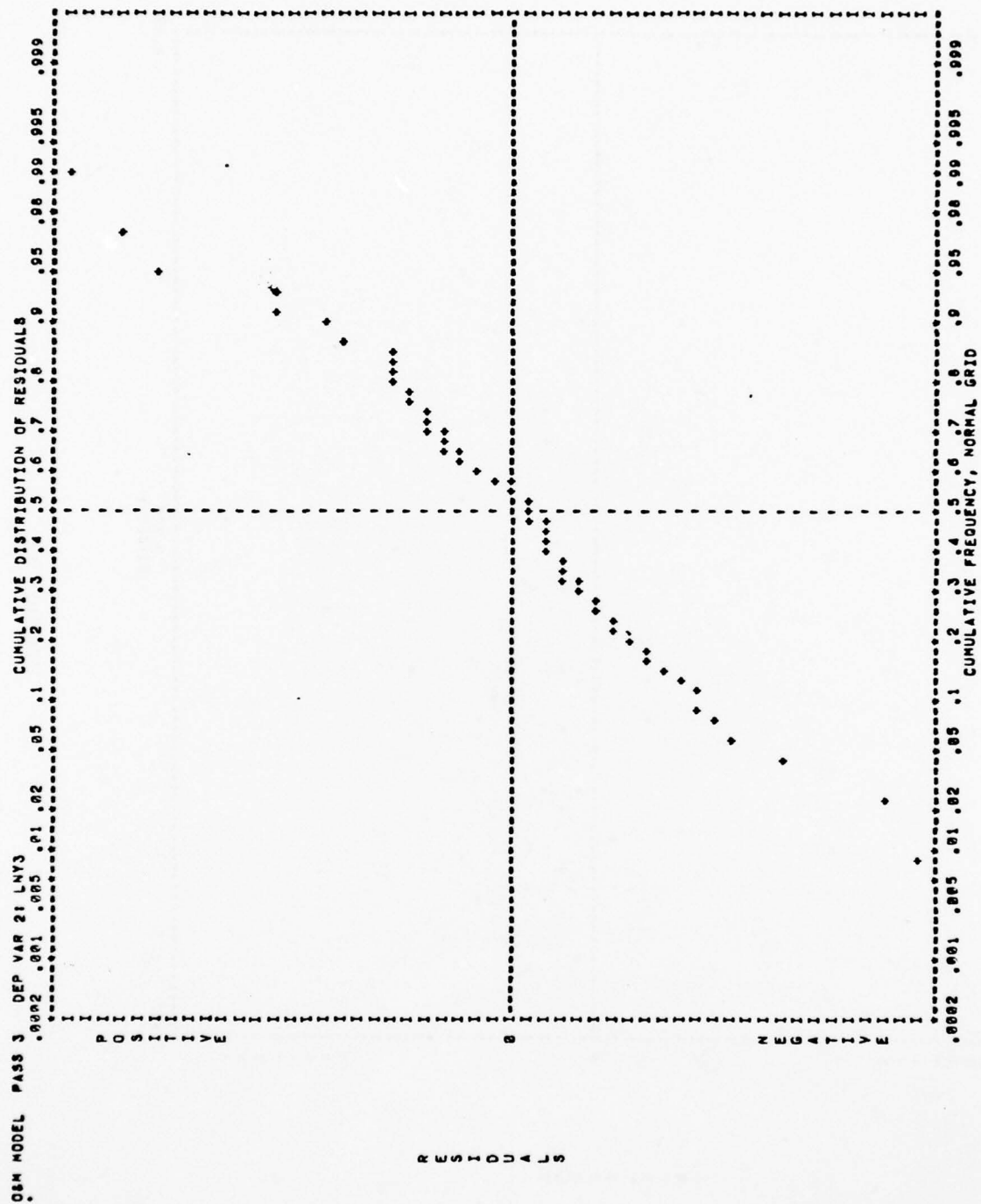


FIGURE 31

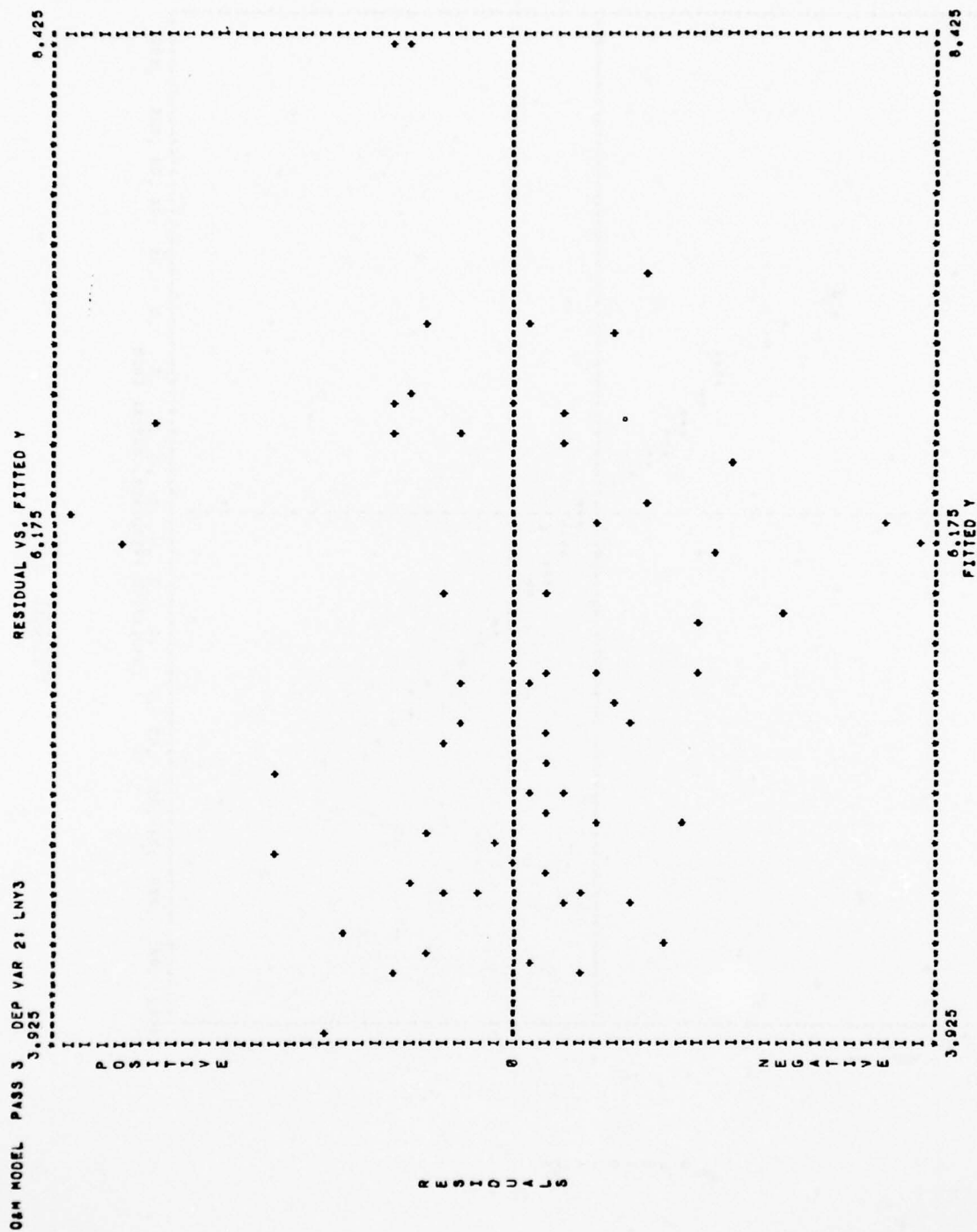


FIGURE 32

pointout which form of the dependent variable was appropriate until the final iterations were made.

After much analysis in the MTBMA fit, it was discovered that \ln MTBMA is the more appropriate form of the dependent to be used. We will then proceed with the sketch of the \ln MTBMA fit. Figures 33-42 are component-plus-residual plots for the ten independent variables X8, X9, X10, X11, X12, X16, X17, X19, X20 and X21. Figure 33 shows that there are 5 observations which extend the range of X8 by 300%. It must be determined whether these observations behave like the rest of the data (thereby extending the range of variable X8) or whether they are not consistent with the remainder of the data (possibly indicating curvature). Table 5 shows the ten independent together with the observations which extend the respective ranges. These observations numbers can be obtained by using the component-plus-residual plots and the tables of data ranked by each independent variable.

Indicator variables in conjunction with the C_p -search technique can be used to determine the effects of such extended observations (see [4]). The approach is to define indicator variables, X22 through X31, denoting those observations which extend the variables shown in Table 5, then multiply these indicator variables by each of their respective independent variables, and use the C_p -search technique to determine if any of these interactions are significant. If any of these products prove to be significant, then curvature will be introduced in the variables, since we have assumed that 7 initial indicator variables sufficiently describes all qualitative information about the observations. This is displayed in Figure 43, where for instance X22 is an indicator variable indicating observations 49, 31, 46, 47 and 34 and X22X8 is the product of X22 and X8.

There are 31 independent variables shown, of which only one belongs to the "basic set," and leaves 30 variables to be searched. The approach

⁴ "The Use of Individual Effects and Residuals in Fitting Equations to Data," F. S. Wood, *Technometrics*, 15, No. 4, (1973), pp. 677-695.

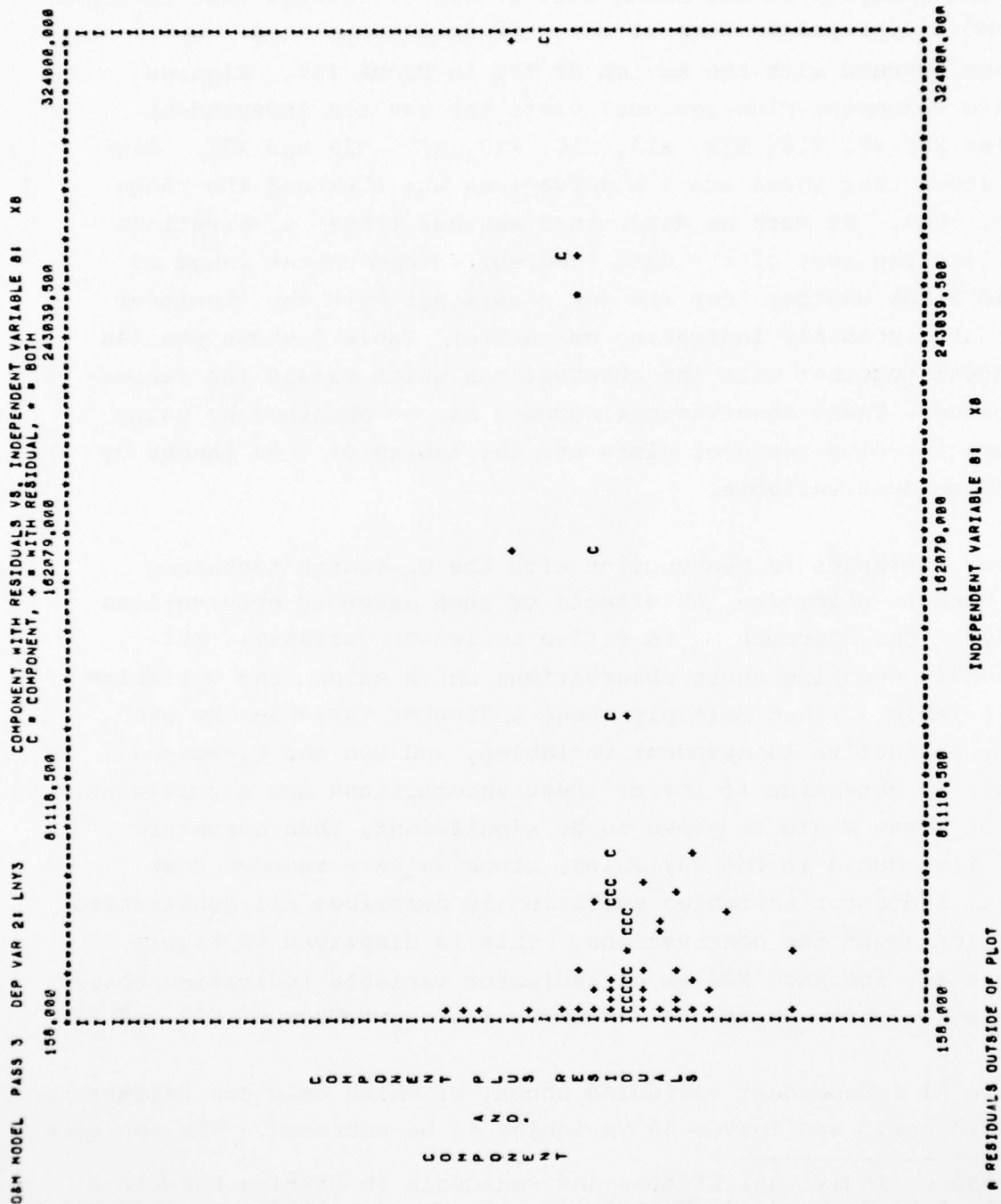


FIGURE 33

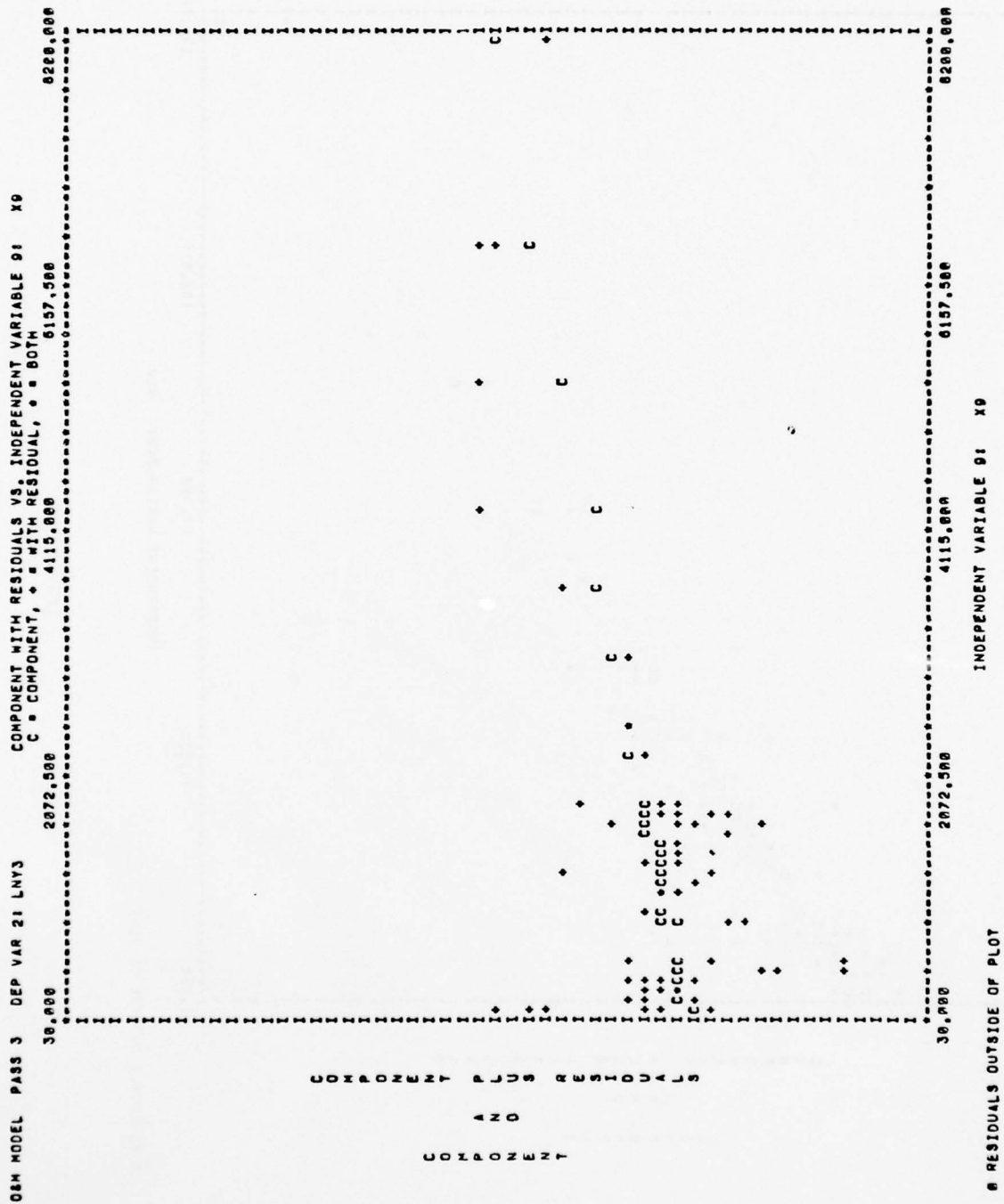


FIGURE 34

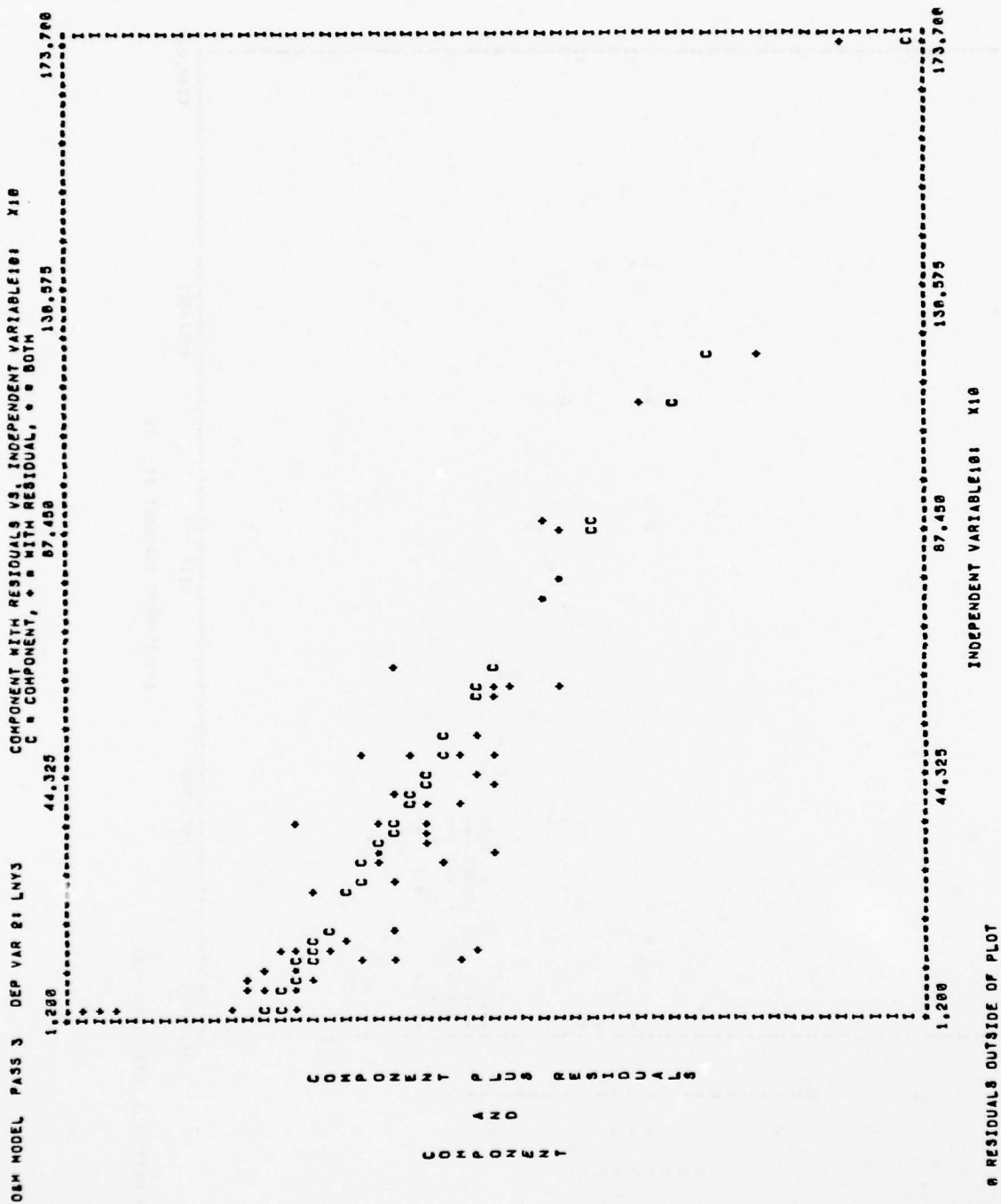


FIGURE 35

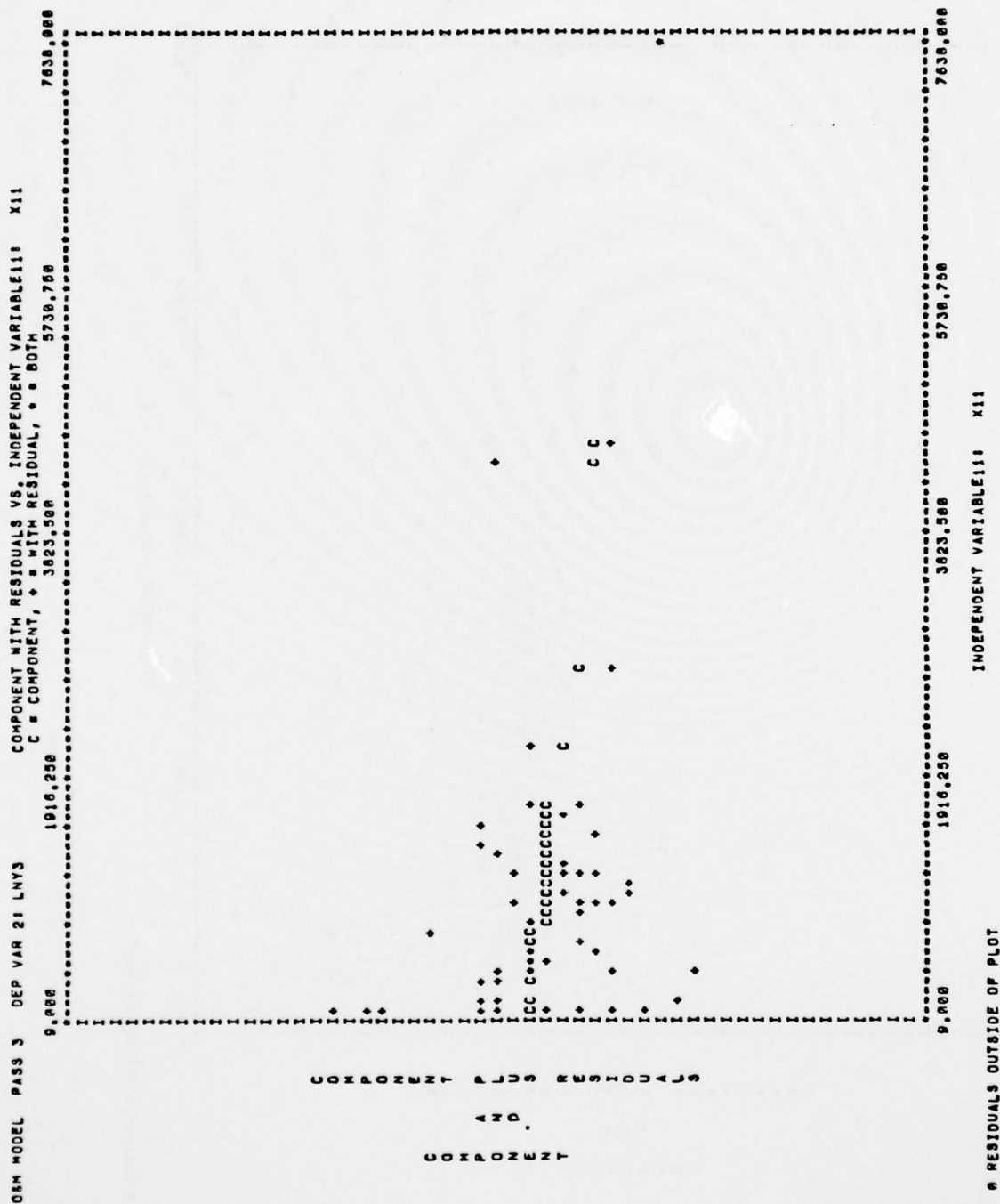


FIGURE 36

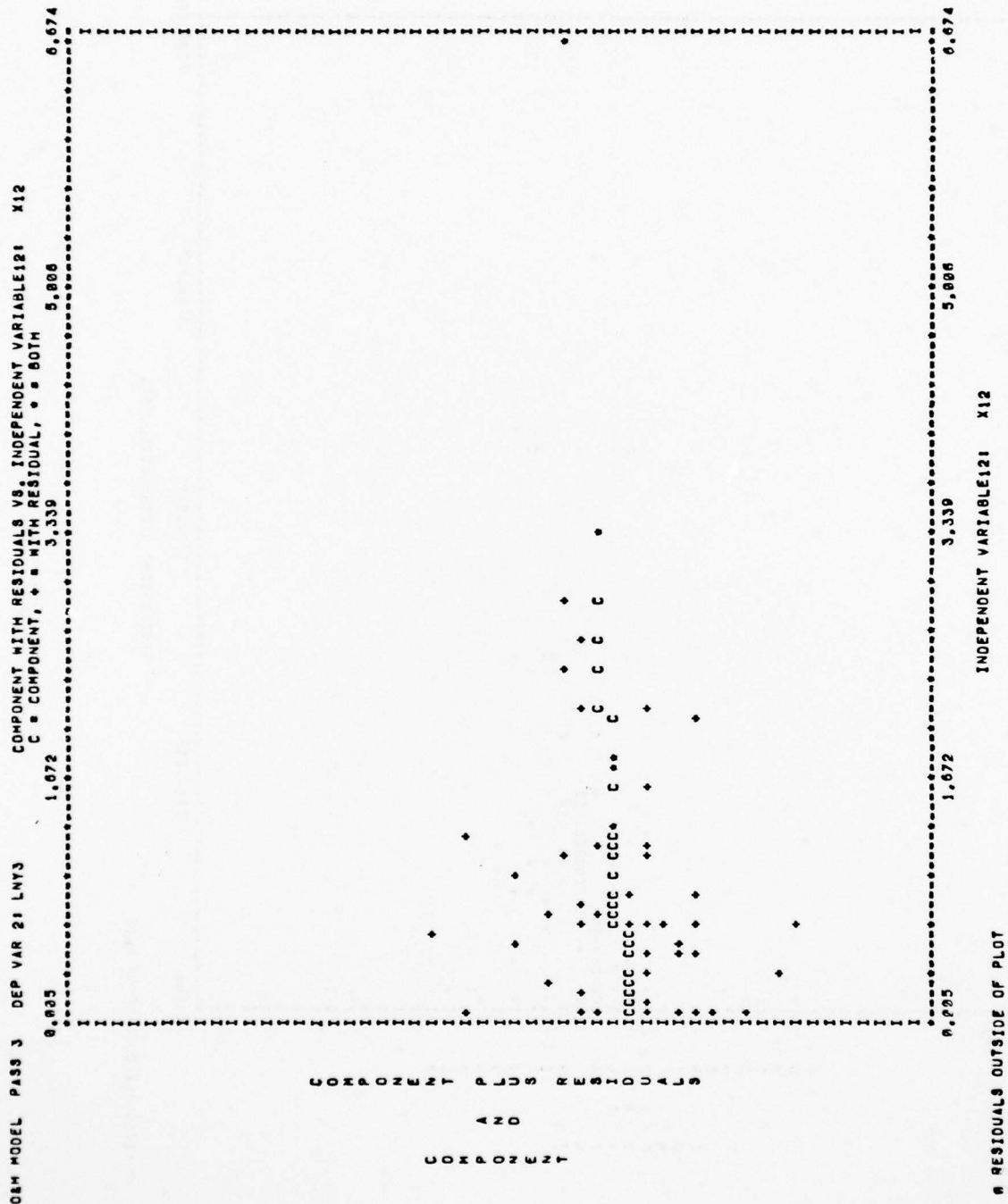


FIGURE 37

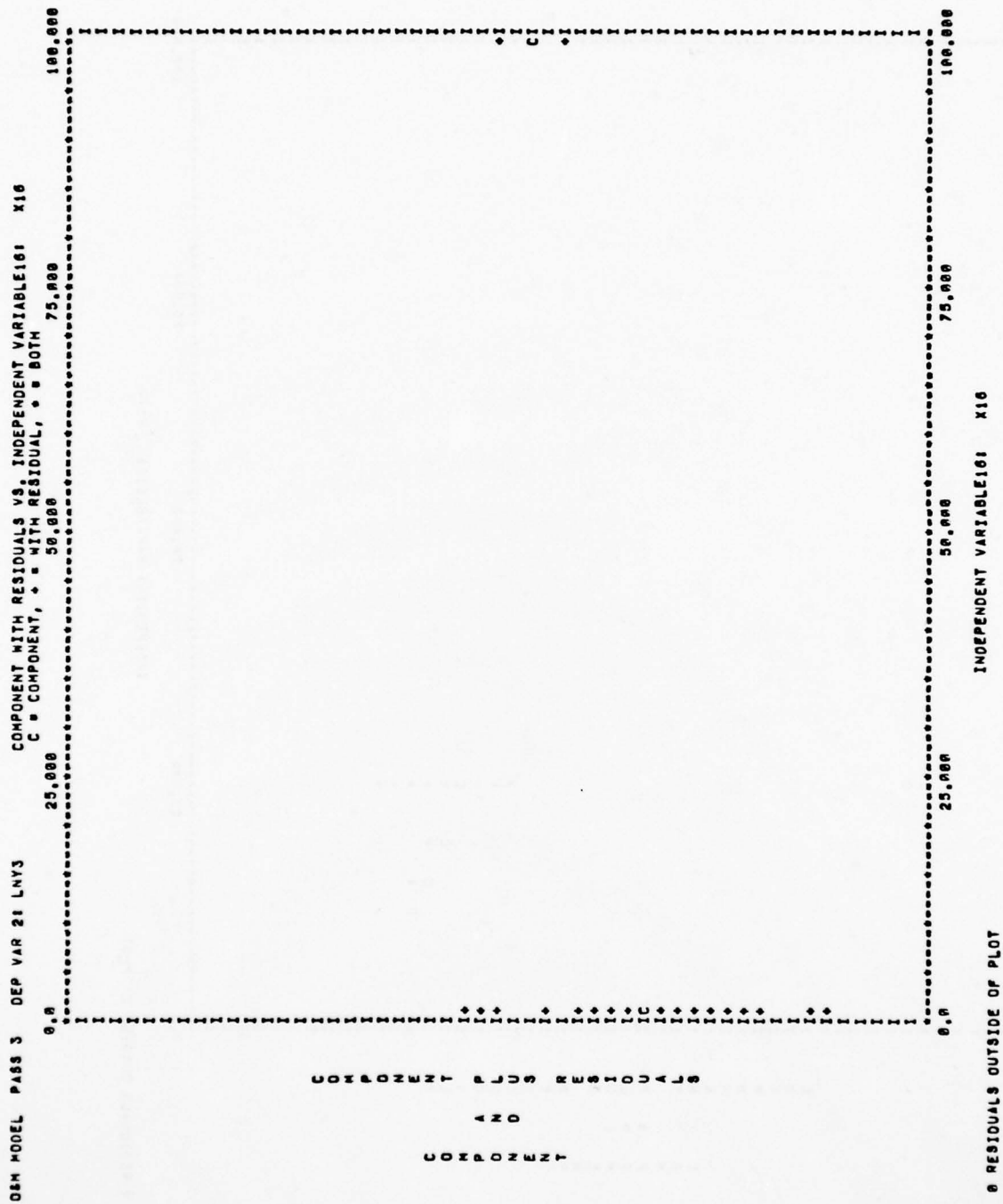


FIGURE 38

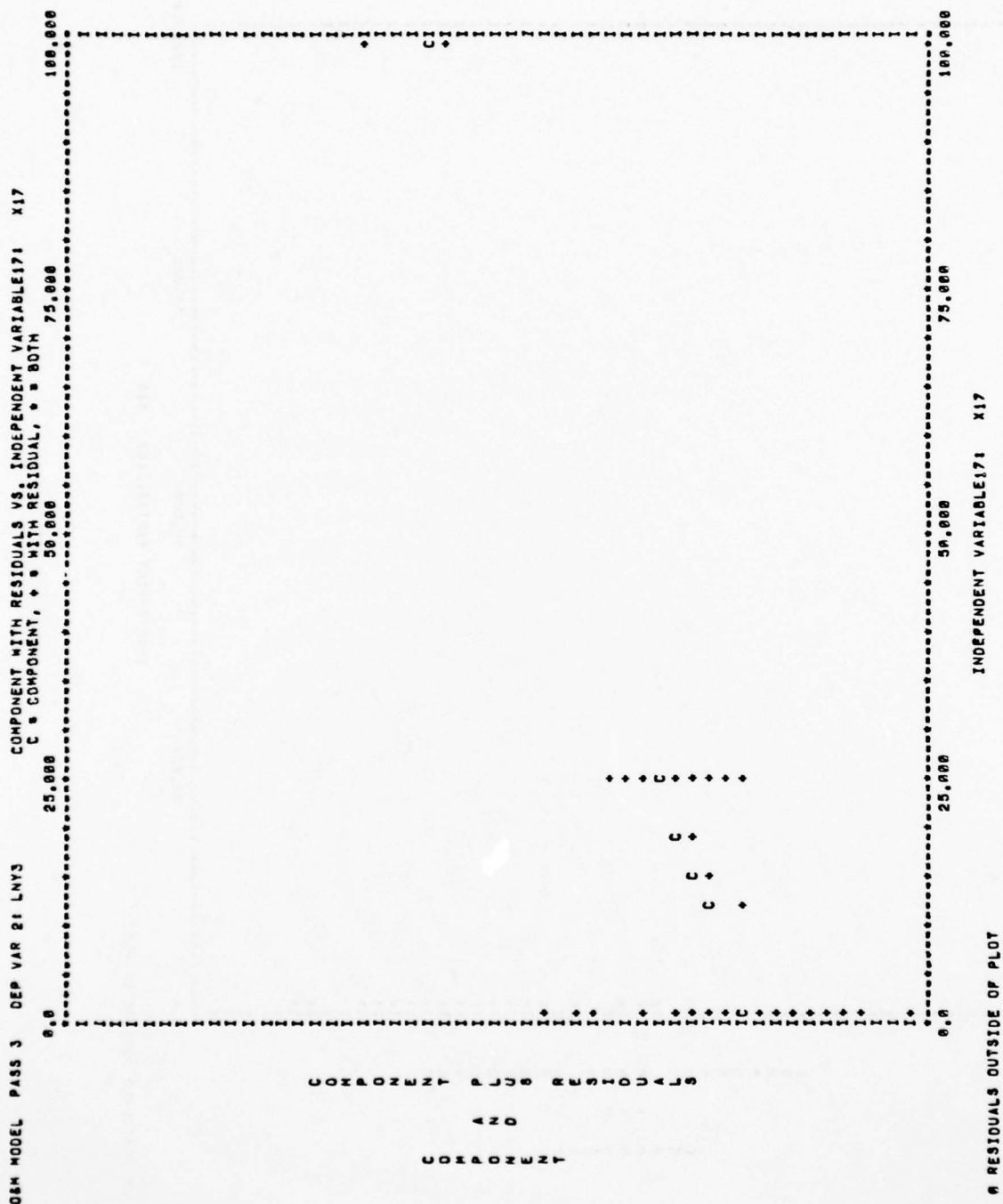


FIGURE 39

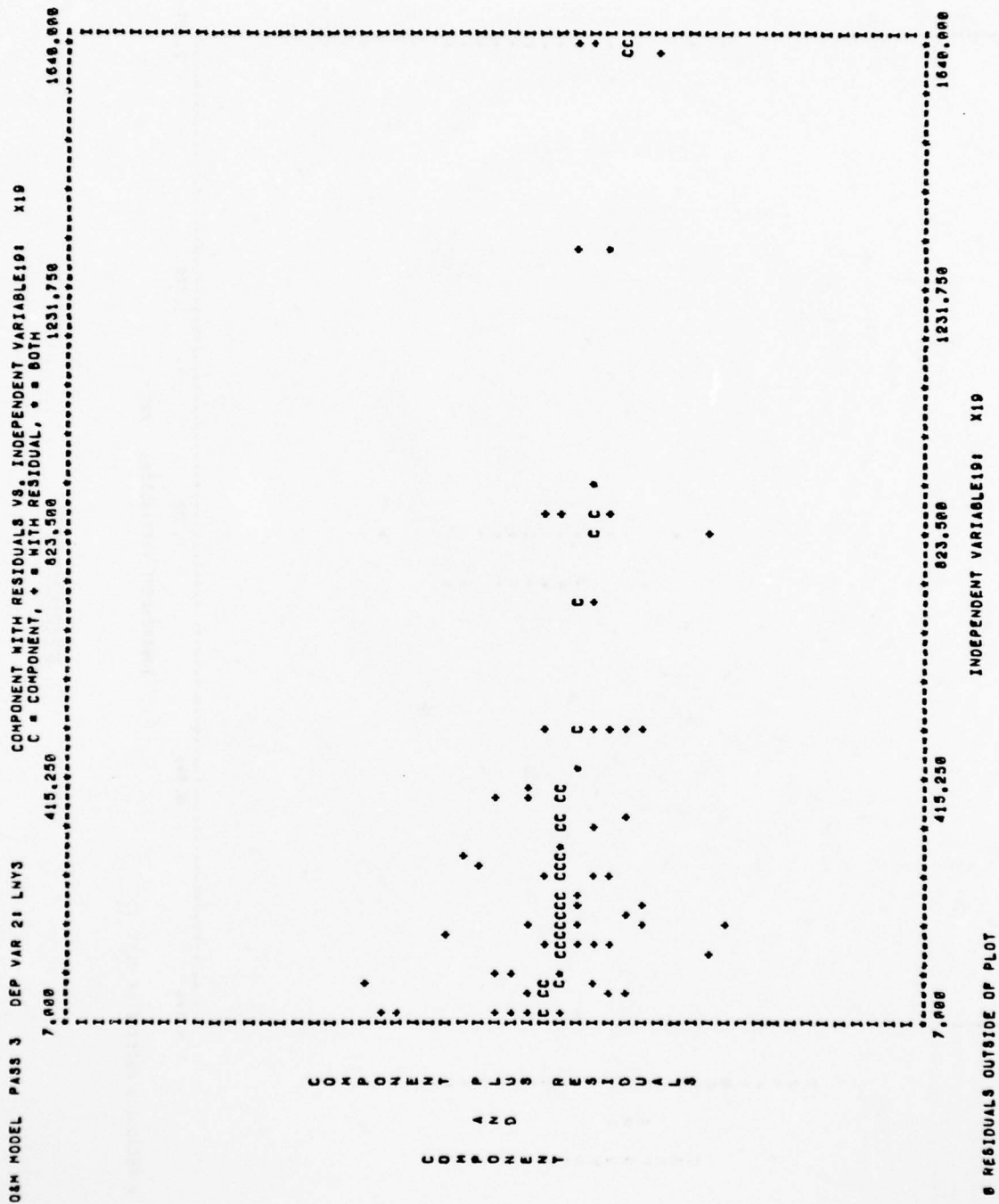


FIGURE 40

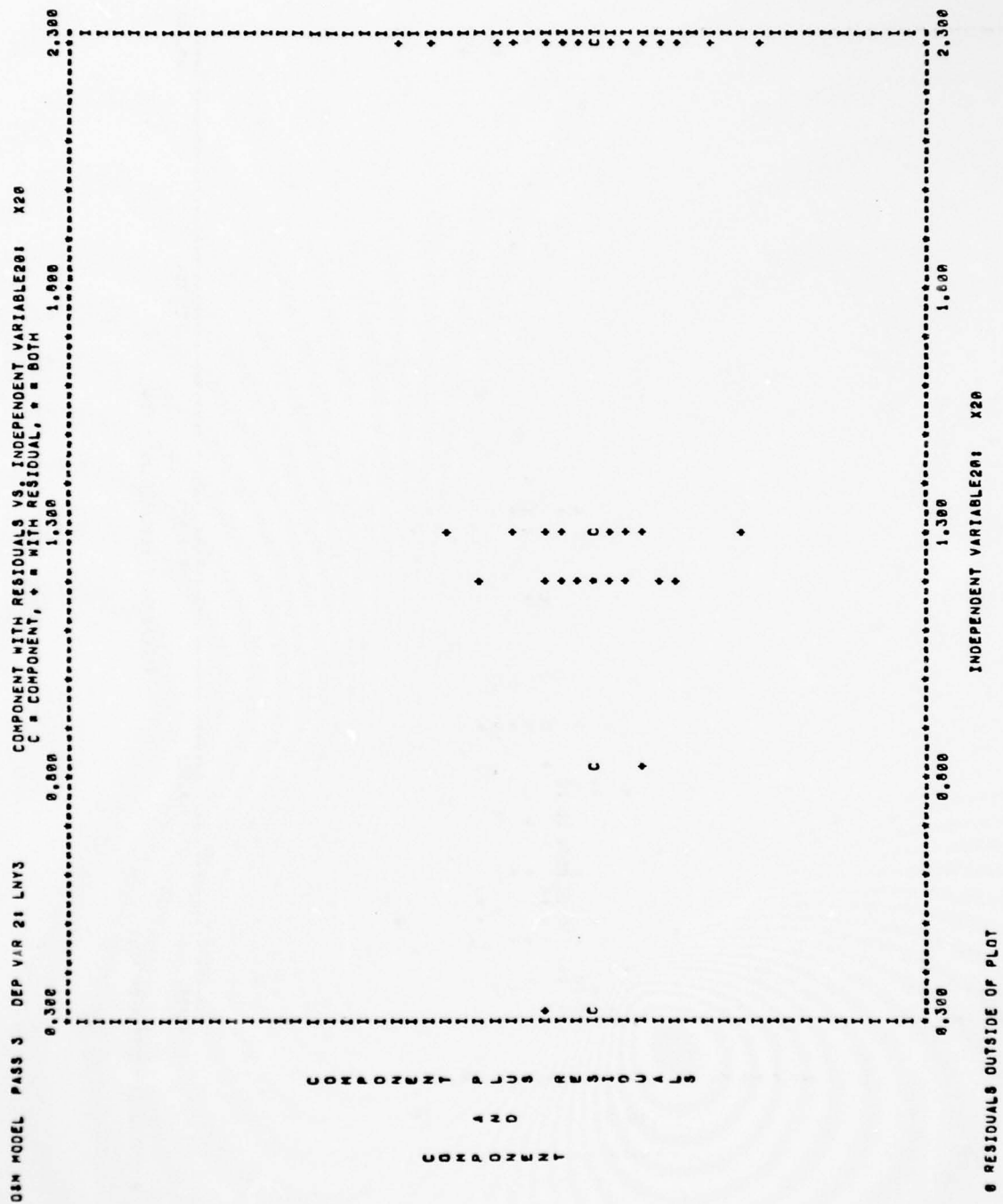


FIGURE 41

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THE AVIONICS LABORATORY PREDICTIVE OPERATIONS AND SUPPORT (ALPO--ETC(U))
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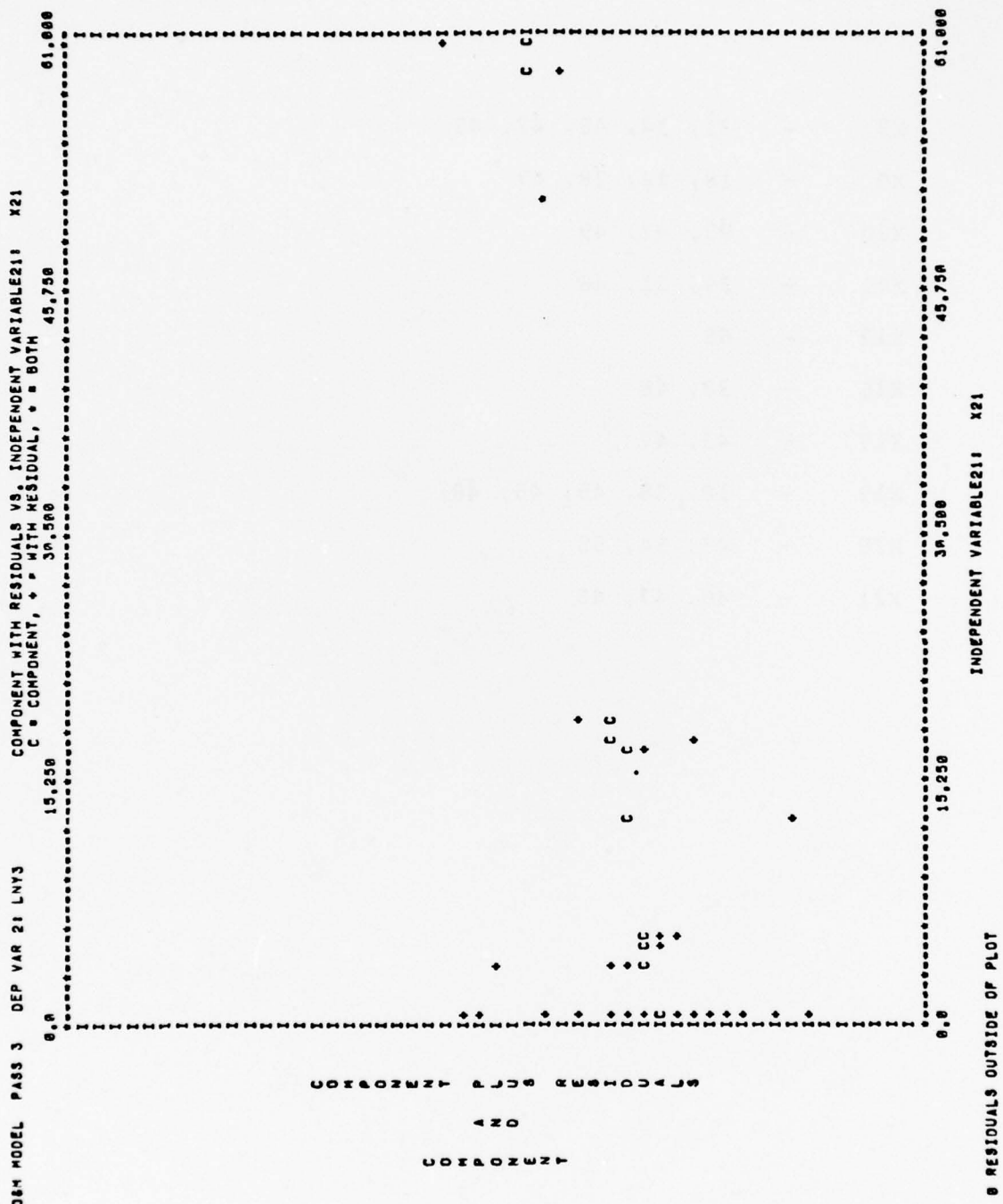


FIGURE 42

TABLE 5

OBSERVATIONS THAT EXTEND THE RANGES OF THE VARIABLES

X8	-	31, 34, 46, 47, 49
X9	-	18, 22, 28, 47
X10	-	22, 47, 49
X11	-	29, 31, 46
X12	-	68
X16	-	38, 48
X17	-	42, 47
X19	-	18, 28, 45, 46, 48
X20	-	45, 54, 55
X21	-	46, 47, 48

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

QRM MODEL PASS 31 DEP VAR 1: Y3 MIN Y = 4.5500 01 MAX Y = 7.5300 03 RANGE Y = 7.4840 03

IND. VAR(I)	NAME	COEF. B(I)	S.E. COEF.	T-VALUE	R(I)SQRD	MIN X(I)	MAX X(I)	RANGE X(I)	REL. INF. X(I)
0		-1.742070 04							
1	X1M	2.323020 02	1.970 03	0.1	0.9797	-2.7400-01	7.2600-01	1.0000 02	0.03
2	X2M	5.596550 01	2.120 03	0.0	0.9826	-2.7400-01	7.2600-01	1.0000 02	0.01
3	X3M	5.351760 02	5.930 02	1.1	0.6876	-2.5800-01	7.4200-01	1.0000 02	0.07
4	X4M	4.279040 02	6.980 02	0.6	0.8824	-2.1000-01	7.9000-01	1.0000 02	0.06
5	X5	3.581990 03	8.790 02	3.7	0.4524	-2.0300-01	5.3870-01	7.4200-01	0.33
6	X6	1.997330 03	9.960 02	1.1	0.5481	-2.1650-01	5.7350-01	7.9000-01	0.12
7	X7	-4.167470 01	9.810 02	0.0	0.5706	-2.1650-01	5.7350-01	7.9000-01	0.09
8	X8	-7.584970-03	1.900-02	0.4	2.9883	1.5800 02	3.2400 05	3.2300 05	0.33
9	X9	-4.257710-01	6.490-01	0.7	0.9859	3.0800 01	8.1700 03	8.1700 03	0.46
10	X10	-1.314520 01	2.940 01	0.4	0.9819	1.2800 00	1.7370 02	1.7350 02	0.38
11	X11	-4.926670-01	5.490-01	0.0	0.9559	0.9800 00	7.6380 03	7.6200 03	0.59
12	X12	4.420040-01	3.890 02	0.0	0.9076	4.9200-03	6.6740 02	6.6600 00	0.09
13	X13	2.162440 02	1.670 02	1.3	0.9889	0.0	1.0000 02	1.0000 02	2.02
14	X14	2.072710 02	1.630 02	1.3	0.9896	0.0	1.0000 02	1.0000 02	2.77
15	X15	2.190900 02	1.630 02	1.3	0.9904	0.0	1.0000 02	1.0000 02	2.01
16	X16	2.052840 02	2.280 02	0.9	0.9990	0.0	1.0000 02	1.0000 02	2.74
17	X17	2.035310 02	1.510 02	1.3	0.9984	0.0	1.0000 02	1.0000 02	2.72
18	X18	-8.670320 00	6.770 00	1.3	0.8001	0.0	1.0000 02	1.0000 02	0.12
19	X19	-2.048140 00	9.610-01	2.1	0.9000	0.0	1.0000 02	1.0000 02	0.45
20	X20	-1.842230 02	1.930 03	0.1	0.9865	3.0800-01	2.3000 00	2.0000 00	0.45
21	X21	-4.432010 01	4.630 01	1.0	0.9342	0.0	6.1000 01	6.1000 01	0.36
22	X22	9.068170-03	2.020-02	0.5	0.9902	0.0	3.2400 05	3.2400 05	0.43
23	X23	4.929140-01	3.470-01	1.4	0.9323	0.0	6.2000 03	6.2000 03	0.54
24	X24	-2.771020 00	2.370 01	0.1	0.9727	0.0	1.7370 02	1.7370 02	0.06
25	X25	4.500770-01	5.730-01	0.9	0.9590	0.0	7.6380 03	7.6380 03	0.48
26	X26	-1.975820 02	3.410 02	0.6	0.8309	0.0	6.6740 00	6.6740 00	0.18
27	X27	8.137390 00	1.430 02	0.1	0.9976	0.0	1.0000 02	1.0000 02	0.11
28	X28	2.094330 01	2.430 01	0.9	0.9151	0.0	1.0000 02	1.0000 02	0.31
29	X29	1.364290 00	1.530 00	0.9	0.9684	0.0	1.6400 03	1.6400 03	0.38
30	X30	-2.314280 03	4.170 03	0.6	0.9684	0.0	8.3000-01	8.3000-01	0.26
31	X31	4.821240 01	6.120 01	0.8	0.9723	0.0	6.1000 01	6.1000 01	0.39

NO. OF OBSERVATIONS 62
 NO. OF IND. VARIABLES 31
 RESIDUAL DEGREES OF FREEDOM 30
 F-VALUE 3.1
 RESIDUAL ROOT MEAN SQUARE 983.10709583
 RESIDUAL MEAN SQUARE 966499.56186898
 RESIDUAL SUM OF SQUARES *****
 TOTAL SUM OF SQUARES 121154112.61084668
 MULT. CORREL. COEF. SQUARED 7.687

FIGURE 43

used to search these variables is to utilize the fractional replication technique twice, where 12 variables are searched at each stage. First of all, the 12 variables numbered 3, 7, 9, 12, 16, 17, 18, 21, 23, 26, 27, 31 have the smallest t_i -values (see Figure 43). The CP search technique indicated that none of the 12 variables searched are significant enough to remain in the equations. These variables are therefore dropped and the remaining variables are fitted (Figure 44). Next, the twelve variables 1, 2, 3, 5, 6, 8, 9, 10, 12, 13, 16, 19 are put through the C_p search technique. This time only variables 3, 6, 10, 12, and 13 are significant and the results are printed in Figure 45.

We note that the variables X22X8, X24X10, X28X17 and X29X19 remain in the resulting equation. Therefore, curvature in the form of squares and natural logarithms for variables X8, X10, X17 and X19 are introduced into the regressions as shown in Figure 46. Since X17 is the % transmitter, there is no logarithm used. In this pass, there are two variables in the basic set. Since there are obviously some variables of negligible influence (see the T-VALUE and REL. INF. X(I)) a search must be made. Again, using a double fractional factorial search, the C_p -search technique admits only the 12 variables shown in Figure 47. (Pass 39). Additional outputs of Pass 39 are shown in Figures 48-51. Since the residual route mean square = .43, the cumulative estimates of the standard deviation indicates that there is little evidence of lack of fit. There are no observations far from the "centroid" of all observations. The cumulative distribution of residuals plot is now a straight line and the fitted y values have a nice even scatter about the 0 - residual line.

There is, however, one observation, 9, which has a larger (smaller) residual than all the other observations (Figure 48). This observation may be controlling the estimates of the coefficients. To determine if observation 9 is in fact controlling some of the coefficients, a cross verification of coefficients is performed as shown in Figure 52, where the statistics at the top are calculated

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

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OEM MODEL PASS 33 DEP VAR 11 Y3
MIN Y = 4.5500 01 MAX Y = 7.5300 03 RANGE Y = 7.4840 03

IND.VAR(I) NAME COEF. R(I) S.D. T-VALUE R(I) S.D. MIN X(I) MAX X(I) RANGE X(I) REL. INF. X(I)
1 X1M 2.142250 03 8.910 02 3.9 0.9154 -2.7400-01 7.2600-01 1.0000 02 0.12
2 X2M 7.483300 02 9.830 02 0.1 0.9325 -2.7400-01 7.2600-01 1.0000 02 0.02
3 X3M 1.202010 02 3.830 02 0.5 0.4509 -2.1000-01 7.9000-01 1.0000 03 0.03
4 X4M -2.929700 02 7.350 02 4.0 0.3251 -2.0330-01 5.2870-01 7.4200-01 0.35
5 X5 3.524270 03 7.130 02 1.8 0.2448 -2.1650-01 5.7350-01 7.9000-01 0.08
6 X6 7.433400 02 1.210-02 2.5 0.9752 1.5800 02 3.2400 03 3.2380 03 1.31
7 X7 -3.024300-02 8.130 00 3.3 0.7365 1.2000 04 1.7370 02 1.7250 02 0.37
8 X8 -2.461630 01 3.260-01 0.7 0.9257 0.0000 00 7.6300 03 7.6290 03 0.23
9 X9 -2.251420-01 1.400 01 0.4 0.7837 0.0 1.0000 02 1.0000 02 0.06
10 X10 -4.472030 00 8.170 00 0.4 0.8478 0.0 1.0000 02 1.0000 02 0.05
11 X11 -3.451900 00 8.430 00 1.4 0.8192 0.0 1.0000 02 1.0000 02 0.16
12 X12 1.284760 01 6.970-01 1.5 0.8382 7.0000 00 1.6400 03 1.6330 03 0.23
13 X13 3.710240 01 8.650 02 0.8 0.9425 3.0000-01 2.5000 00 2.0000 00 0.01
14 X14 2.922900-02 1.190-02 2.4 0.9768 0.0 3.2400 03 3.2400 03 1.27
15 X15 1.242070 01 2.390 00 1.5 0.7832 0.0 1.7370 02 1.7370 02 0.29
16 X16 2.602130-01 2.000-01 0.9 0.8930 0.0 7.6300 03 7.6300 03 0.27
17 X17 1.930000 01 1.100 01 1.8 0.6475 0.0 1.0000 02 1.0000 02 0.06
18 X18 1.501800 00 6.150-01 2.4 0.7909 0.0 1.6400 03 1.6400 03 0.33
19 X19 7.777310 02 1.910 03 5.4 0.8391 0.0 8.3000-01 8.3000-01 0.09

```

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NO. OF OBSERVATIONS 19
NO. OF IND. VARIABLES 19
RESIDUAL DEGREES OF FREEDOM 02
F-VALUE 9.5
RESIDUAL ROOT MEAN SQUARE 018.61630039
RESIDUAL MEAN SQUARE 829222.15581297
RESIDUAL SUM OF SQUARES *****
TOTAL SUM OF SQUARES 12115412.01004008
MULT. CORREL. COEF. SQUARED .7125

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REQUIRED X(I) PRECISION
(DIGIT RIGHT OF DECIMAL POSITIVE,
LEFT OF DECIMAL NEGATIVE)

IND.VAR(I)	DIGIT
1	1
2	1
3	1
4	1
5	1
6	-5
7	-2
8	-3
9	-3
10	-2
11	-2
12	-3
13	1
14	-5
15	-2
16	-4
17	-2
18	-3
19	1

FIGURE 44

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

Q8M MODEL PASS 34" DEP VAR 11 LNY3 MIN Y = 3.8180 00 MAX Y = 8.9270 00 RANGE Y = 5.1090 00

IND.VAR(I)	NAME	COEF. R(I)	S.E. COEF.	T-VALUE	R(I)SQD	MIN X(I)	MAX X(I)	RANGE X(I)	REL.INF.X(I)
0		6.63500 00							
1	X4M	-5.238320-01	2.190-01	2.4	0.2343	-2.1000-01	7.9000-01	1.0000 00	0.10
2	X5	1.435000 00	4.370-01	3.3	0.1327	-2.0330-01	5.3870-01	7.4200-01	0.21
3	X8	-1.901260-05	6.050-06	2.9	0.0030	1.5000 02	3.2470 03	3.2000 05	1.21
4	X10	-3.571470-02	4.000-03	7.3	0.7454	1.2000 00	1.7370 02	1.7000 02	1.21
5	X14	9.117480-03	4.070-03	2.2	0.7210	0.0	1.0000 02	1.0000 02	0.10
6	X15	1.847840-02	3.910-03	4.7	0.6170	0.0	1.0000 02	1.0000 02	0.36
7	X19	-7.418110-24	4.060-04	1.8	0.7830	7.0000 00	1.6400 03	1.6300 03	0.24
8	X20	-2.452780-21	1.530-01	1.6	0.1575	3.0000-01	2.3000 03	2.0000 00	0.10
9	X2248	1.951840-05	6.320-06	3.1	0.9510	0.0	3.2400 05	3.2400 05	1.24
10	X24X10	1.420590-02	5.040-03	2.8	0.7224	0.0	1.7370 02	1.7370 02	0.40
11	X28X17	2.636640-02	6.750-03	3.9	0.5720	0.0	1.0000 02	1.0000 02	0.52
12	X29X19	1.316130-03	3.490-04	3.8	0.7044	0.0	1.6400 03	1.6400 03	0.42

NO. OF OBSERVATIONS 62
 NO. OF IND. VARIABLES 12
 RESIDUAL DEGREES OF FREEDOM 49
 F-VALUE 15.9
 RESIDUAL ROOT MEAN SQUARE 0.61431588
 RESIDUAL MEAN SQUARE 0.37738398
 RESIDUAL SUM OF SQUARES 18.49181129
 TOTAL SUM OF SQUARES 98.47129848
 MULT. CORREL. COEF. SQUARED .7956

REQUIRED X(I) PRECISION
 (DIGIT RIGHT OF DECIMAL POSITIVE,
 LEFT OF DECIMAL NEGATIVE)

IND.VAR(I)	DIGIT
1	1
2	1
3	-5
4	-2
5	-2
6	-2
7	-3
8	1
9	-5
10	-2
11	-2
12	-3

FIGURE 45

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

Q&M MODEL PASS 35 DEP VAR 11 LNY3 MIN Y = 3.8180 MR MAX Y = 8.9270 PR RANGE Y = 5.1090 RP

INO. VAR(I)	NAME	COEF. R(I)	S.E. COEF.	T-VALUE	R(I)SSQRD	MIN X(I)	MAX X(I)	RANGE X(I)	REL. INF. X(I)
1	X1M	3.178190 RP	3.270-01	8.4	0.8301	-2.7470-01	7.2840-01	1.0360-01	0.03
2	X2M	-1.287520-01	3.680-01	0.1	0.8468	-2.7470-01	7.2840-01	1.0360-01	0.03
3	X3M	-2.852250-02	2.280-01	1.8	0.8312	-2.7470-01	7.2840-01	1.0360-01	0.03
4	X4M	2.995800-01	2.530-01	0.6	0.8761	-2.7470-01	7.2840-01	1.0360-01	0.03
5	X5	-1.537750-01	4.300-01	4.3	0.8378	-2.7470-01	7.2840-01	1.0360-01	0.03
6	X6	1.733460 RP	4.180-01	1.4	0.8347	-2.7470-01	7.2840-01	1.0360-01	0.03
7	X7	-5.939250-01	4.830-01	0.7	0.8379	-2.7470-01	7.2840-01	1.0360-01	0.03
8	X8	-2.699470-01	1.430-01	2.2	0.8379	-2.7470-01	7.2840-01	1.0360-01	0.03
9	X9	2.175720-05	1.430-01	0.0	0.8379	-2.7470-01	7.2840-01	1.0360-01	0.03
10	X10	2.125230-06	1.430-01	0.0	0.8379	-2.7470-01	7.2840-01	1.0360-01	0.03
11	X11	3.546370-09	1.430-01	0.0	0.8379	-2.7470-01	7.2840-01	1.0360-01	0.03
12	X12	9.675730-09	1.430-01	0.0	0.8379	-2.7470-01	7.2840-01	1.0360-01	0.03
13	X13	1.759840-01	0.410-02	1.3	0.8379	-2.7470-01	7.2840-01	1.0360-01	0.03
14	X14	9.451130-02	0.410-02	1.3	0.8379	-2.7470-01	7.2840-01	1.0360-01	0.03
15	X15	7.431870-03	3.070-03	2.4	0.8379	-2.7470-01	7.2840-01	1.0360-01	0.03
16	X16	-1.862210-01	3.070-03	0.6	0.8379	-2.7470-01	7.2840-01	1.0360-01	0.03
17	X17	1.717430-02	1.190-02	1.4	0.8379	-2.7470-01	7.2840-01	1.0360-01	0.03
18	X18	1.684700-06	3.740-06	2.4	0.8379	-2.7470-01	7.2840-01	1.0360-01	0.03
19	X19M	1.339110-02	1.220-02	1.1	0.8379	-2.7470-01	7.2840-01	1.0360-01	0.03
20	X20	9.657330-02	6.490-02	1.3	0.8379	-2.7470-01	7.2840-01	1.0360-01	0.03
21	X21M	8.284920-03	4.580-02	0.2	0.8379	-2.7470-01	7.2840-01	1.0360-01	0.03
22	X22	-7.284920-12	2.920-11	0.2	0.8379	-2.7470-01	7.2840-01	1.0360-01	0.03
23	X10S0	-1.222620-04	0.830-05	1.4	0.8379	-2.7470-01	7.2840-01	1.0360-01	0.03
24	X170S0	1.484990-04	1.330-05	1.0	0.8379	-2.7470-01	7.2840-01	1.0360-01	0.03
25	X190S0	4.844520-07	0.880-07	0.7	0.8379	-2.7470-01	7.2840-01	1.0360-01	0.03
26	LNYR	-2.071710-01	1.570-01	2.3	0.8379	-2.7470-01	7.2840-01	1.0360-01	0.03
27	LNYR	-9.152640-01	2.530-01	3.6	0.8379	-2.7470-01	7.2840-01	1.0360-01	0.03
28	LNYR	-1.859330-01	1.610-01	0.7	0.8379	-2.7470-01	7.2840-01	1.0360-01	0.03

NO. OF OBSERVATIONS 62
 NO. OF INO. VARIABLES 28
 RESIDUAL DEGREES OF FREEDOM 33
 F-VALUE 14.6
 RESIDUAL ROOT MEAN SQUARE 0.46124574
 RESIDUAL MEAN SQUARE 0.21274783
 RESIDUAL SUM OF SQUARES 7.2267193
 TOTAL SUM OF SQUARES 98.47129248
 MULT. CORREL. COEF. SQUARED .9224

REQUIRED X(I) PRECISION
 (DIGIT RIGHT OF DECIMAL POSITIVE,
 LEFT OF DECIMAL NEGATIVE)

INO. VAR(I)	DIGIT
1	1
2	1
3	1
4	1
5	1
6	1
7	1
8	1
9	1
10	1
11	1
12	1
13	1
14	1
15	1
16	1
17	1
18	1
19	1
20	1
21	1
22	1
23	1
24	1
25	1
26	1

FIGURE 46

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

Q&M MODEL PASS 39 DEP VAR 11 LMY3 MIN Y = 3.8180 00 MAX Y = 8.9270 00 RANGE Y = 5.1090 00

IND.VAR(I)	NAME	COEF.B(I)	S.E. COEF.	T-VALUE	R(I)SQD	MIN X(I)	MAX X(I)	RANGE X(I)	REL.INF.X(I)
0									
1	X3M	1.833760 01	1.490-01	1.8	0.3874	-2.5980-01	7.4200-01	1.0000 00	0.06
2	X5	2.902270-01	3.370-01	5.2	0.2190	-2.0330-01	5.3870-01	7.4200-01	0.25
3	X8	1.689440 00	3.320-01	2.0	0.2117	-2.1650-01	5.7350-01	7.9000-01	0.12
4	X15	6.529480-01	3.130-03	5.6	0.7252	0.0	1.0000 02	1.0000 02	0.34
5	X18	1.785490-02	2.450-03	2.3	0.7244	0.0	1.0000 02	1.0000 02	0.11
6	X21	5.665570-03	6.410-03	1.2	0.5373	0.0	6.1000 01	6.1000 01	0.09
7	X10M	7.840460-03	5.330-03	2.6	0.6935	-3.5980 01	1.3750 02	1.7250 02	0.48
8	X12DSQ	1.407940-02	6.800-05	1.4	0.7486	2.9500 00	1.1700 04	1.1700 04	0.22
9	X170SQ	-8.732620-05	1.810-04	2.8	0.4788	2.3410 02	3.5640 03	3.3300 03	0.13
10	X190SQ	2.020770-04	3.410-07	2.2	0.3479	4.8400 02	8.0900 05	8.2900 05	0.12
11	LX8	7.034000-07	6.260-02	3.8	0.6618	5.0000 00	1.2000 01	7.6260 00	0.35
12	LX10	-2.377390-01	1.630-01	5.5	0.9148	1.0230-01	5.1570 00	4.9750 00	0.99

NO. OF OBSERVATIONS 62
 NO. OF IND. VARIABLES 12
 RESIDUAL DEGREES OF FREEDOM 49
 F-VALUE 36.3
 RESIDUAL ROOT MEAN SQUARE 0.43229300
 RESIDUAL MEAN SQUARE 0.18987542
 RESIDUAL SUM OF SQUARES 9.15689566
 TOTAL SUM OF SQUARES 98.47120040
 MULT. CORREL. COEF. SQUARED .8988

REQUIRED X(I) PRECISION
 (DIGIT RIGHT OF DECIMAL POSITIVE,
 LEFT OF DECIMAL NEGATIVE)

IND.VAR(I)	DIGIT
1	1
2	1
3	1
4	-2
5	-2
6	-2
7	-2
8	-4
9	-4
10	-6
11	1
12	1

FIGURE 47

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

ORIG MODEL PASS 39 DEP VAR 11 LNY3

ORDERED BY COMPUTER INPUT				ORDERED BY RESIDUALS			
IDENT	OBSV.	WSS DISTANCE	OBS. Y	FITTED Y	RESIDUAL	OBS. Y	FITTED Y
71A2A	1	1	5.733	5.733	0.000	5.733	5.733
71B3A	2	2	5.732	5.732	0.000	5.732	5.732
71C3A	3	3	5.731	5.731	0.000	5.731	5.731
71D3A	4	4	5.730	5.730	0.000	5.730	5.730
71E3A	5	5	5.729	5.729	0.000	5.729	5.729
71F3A	6	6	5.728	5.728	0.000	5.728	5.728
71G3A	7	7	5.727	5.727	0.000	5.727	5.727
71H3A	8	8	5.726	5.726	0.000	5.726	5.726
71I3A	9	9	5.725	5.725	0.000	5.725	5.725
71J3A	10	10	5.724	5.724	0.000	5.724	5.724
71K3A	11	11	5.723	5.723	0.000	5.723	5.723
71L3A	12	12	5.722	5.722	0.000	5.722	5.722
71M3A	13	13	5.721	5.721	0.000	5.721	5.721
71N3A	14	14	5.720	5.720	0.000	5.720	5.720
71O3A	15	15	5.719	5.719	0.000	5.719	5.719
71P3A	16	16	5.718	5.718	0.000	5.718	5.718
71Q3A	17	17	5.717	5.717	0.000	5.717	5.717
71R3A	18	18	5.716	5.716	0.000	5.716	5.716
71S3A	19	19	5.715	5.715	0.000	5.715	5.715
71T3A	20	20	5.714	5.714	0.000	5.714	5.714
71U3A	21	21	5.713	5.713	0.000	5.713	5.713
71V3A	22	22	5.712	5.712	0.000	5.712	5.712
71W3A	23	23	5.711	5.711	0.000	5.711	5.711
71X3A	24	24	5.710	5.710	0.000	5.710	5.710
71Y3A	25	25	5.709	5.709	0.000	5.709	5.709
71Z3A	26	26	5.708	5.708	0.000	5.708	5.708
72A3A	27	27	5.707	5.707	0.000	5.707	5.707
72B3A	28	28	5.706	5.706	0.000	5.706	5.706
72C3A	29	29	5.705	5.705	0.000	5.705	5.705
72D3A	30	30	5.704	5.704	0.000	5.704	5.704
72E3A	31	31	5.703	5.703	0.000	5.703	5.703
72F3A	32	32	5.702	5.702	0.000	5.702	5.702
72G3A	33	33	5.701	5.701	0.000	5.701	5.701
72H3A	34	34	5.700	5.700	0.000	5.700	5.700
72I3A	35	35	5.699	5.699	0.000	5.699	5.699
72J3A	36	36	5.698	5.698	0.000	5.698	5.698
72K3A	37	37	5.697	5.697	0.000	5.697	5.697
72L3A	38	38	5.696	5.696	0.000	5.696	5.696
72M3A	39	39	5.695	5.695	0.000	5.695	5.695
72N3A	40	40	5.694	5.694	0.000	5.694	5.694
72O3A	41	41	5.693	5.693	0.000	5.693	5.693
72P3A	42	42	5.692	5.692	0.000	5.692	5.692
72Q3A	43	43	5.691	5.691	0.000	5.691	5.691
72R3A	44	44	5.690	5.690	0.000	5.690	5.690
72S3A	45	45	5.689	5.689	0.000	5.689	5.689
72T3A	46	46	5.688	5.688	0.000	5.688	5.688
72U3A	47	47	5.687	5.687	0.000	5.687	5.687
72V3A	48	48	5.686	5.686	0.000	5.686	5.686
72W3A	49	49	5.685	5.685	0.000	5.685	5.685
72X3A	50	50	5.684	5.684	0.000	5.684	5.684
72Y3A	51	51	5.683	5.683	0.000	5.683	5.683
72Z3A	52	52	5.682	5.682	0.000	5.682	5.682
73A3A	53	53	5.681	5.681	0.000	5.681	5.681
73B3A	54	54	5.680	5.680	0.000	5.680	5.680
73C3A	55	55	5.679	5.679	0.000	5.679	5.679
73D3A	56	56	5.678	5.678	0.000	5.678	5.678
73E3A	57	57	5.677	5.677	0.000	5.677	5.677
73F3A	58	58	5.676	5.676	0.000	5.676	5.676
73G3A	59	59	5.675	5.675	0.000	5.675	5.675
73H3A	60	60	5.674	5.674	0.000	5.674	5.674
73I3A	61	61	5.673	5.673	0.000	5.673	5.673
73J3A	62	62	5.672	5.672	0.000	5.672	5.672
73K3A	63	63	5.671	5.671	0.000	5.671	5.671
73L3A	64	64	5.670	5.670	0.000	5.670	5.670
73M3A	65	65	5.669	5.669	0.000	5.669	5.669
73N3A	66	66	5.668	5.668	0.000	5.668	5.668
73O3A	67	67	5.667	5.667	0.000	5.667	5.667
73P3A	68	68	5.666	5.666	0.000	5.666	5.666
73Q3A	69	69	5.665	5.665	0.000	5.665	5.665
73R3A	70	70	5.664	5.664	0.000	5.664	5.664
73S3A	71	71	5.663	5.663	0.000	5.663	5.663
73T3A	72	72	5.662	5.662	0.000	5.662	5.662
73U3A	73	73	5.661	5.661	0.000	5.661	5.661
73V3A	74	74	5.660	5.660	0.000	5.660	5.660
73W3A	75	75	5.659	5.659	0.000	5.659	5.659
73X3A	76	76	5.658	5.658	0.000	5.658	5.658
73Y3A	77	77	5.657	5.657	0.000	5.657	5.657
73Z3A	78	78	5.656	5.656	0.000	5.656	5.656
74A3A	79	79	5.655	5.655	0.000	5.655	5.655
74B3A	80	80	5.654	5.654	0.000	5.654	5.654
74C3A	81	81	5.653	5.653	0.000	5.653	5.653
74D3A	82	82	5.652	5.652	0.000	5.652	5.652
74E3A	83	83	5.651	5.651	0.000	5.651	5.651
74F3A	84	84	5.650	5.650	0.000	5.650	5.650
74G3A	85	85	5.649	5.649	0.000	5.649	5.649
74H3A	86	86	5.648	5.648	0.000	5.648	5.648
74I3A	87	87	5.647	5.647	0.000	5.647	5.647
74J3A	88	88	5.646	5.646	0.000	5.646	5.646
74K3A	89	89	5.645	5.645	0.000	5.645	5.645
74L3A	90	90	5.644	5.644	0.000	5.644	5.644
74M3A	91	91	5.643	5.643	0.000	5.643	5.643
74N3A	92	92	5.642	5.642	0.000	5.642	5.642
74O3A	93	93	5.641	5.641	0.000	5.641	5.641
74P3A	94	94	5.640	5.640	0.000	5.640	5.640
74Q3A	95	95	5.639	5.639	0.000	5.639	5.639
74R3A	96	96	5.638	5.638	0.000	5.638	5.638
74S3A	97	97	5.637	5.637	0.000	5.637	5.637
74T3A	98	98	5.636	5.636	0.000	5.636	5.636
74U3A	99	99	5.635	5.635	0.000	5.635	5.635
74V3A	100	100	5.634	5.634	0.000	5.634	5.634

FIGURE 48

OLM MODEL PASS 39 DEP VAR 1: LNY3
 LINEAR LEAST-SQUARES CURVE FITTING PROGRAM
 RESIDUAL ROOT MEAN SQUARE OF FITTED EQUATION: 0.43
 STANDARD DEVIATION ESTIMATED FROM RESIDUALS OF NEIGHBORING OBSERVATIONS (OBSERVATIONS 1 TO 4 APART IN FITTED Y ORDER).

NO.	CUMULATIVE		ORDERED BY MSO		ORDERED BY FITTED Y		SEQ.
	STD DEV	SSO	OROV	DEL	RESIDUALS	DEL	
1	0.09	2.2	51	0.09	7.52	0.15	1
2	0.09	2.2	51	0.09	7.52	0.15	2
3	0.09	2.2	51	0.09	7.52	0.15	3
4	0.09	2.2	51	0.09	7.52	0.15	4
5	0.09	2.2	51	0.09	7.52	0.15	5
6	0.09	2.2	51	0.09	7.52	0.15	6
7	0.09	2.2	51	0.09	7.52	0.15	7
8	0.09	2.2	51	0.09	7.52	0.15	8
9	0.09	2.2	51	0.09	7.52	0.15	9
10	0.09	2.2	51	0.09	7.52	0.15	10
11	0.09	2.2	51	0.09	7.52	0.15	11
12	0.09	2.2	51	0.09	7.52	0.15	12
13	0.09	2.2	51	0.09	7.52	0.15	13
14	0.09	2.2	51	0.09	7.52	0.15	14
15	0.09	2.2	51	0.09	7.52	0.15	15
16	0.09	2.2	51	0.09	7.52	0.15	16
17	0.09	2.2	51	0.09	7.52	0.15	17
18	0.09	2.2	51	0.09	7.52	0.15	18
19	0.09	2.2	51	0.09	7.52	0.15	19
20	0.09	2.2	51	0.09	7.52	0.15	20
21	0.09	2.2	51	0.09	7.52	0.15	21
22	0.09	2.2	51	0.09	7.52	0.15	22
23	0.09	2.2	51	0.09	7.52	0.15	23
24	0.09	2.2	51	0.09	7.52	0.15	24
25	0.09	2.2	51	0.09	7.52	0.15	25
26	0.09	2.2	51	0.09	7.52	0.15	26
27	0.09	2.2	51	0.09	7.52	0.15	27
28	0.09	2.2	51	0.09	7.52	0.15	28
29	0.09	2.2	51	0.09	7.52	0.15	29
30	0.09	2.2	51	0.09	7.52	0.15	30
31	0.09	2.2	51	0.09	7.52	0.15	31
32	0.09	2.2	51	0.09	7.52	0.15	32
33	0.09	2.2	51	0.09	7.52	0.15	33
34	0.09	2.2	51	0.09	7.52	0.15	34
35	0.09	2.2	51	0.09	7.52	0.15	35
36	0.09	2.2	51	0.09	7.52	0.15	36
37	0.09	2.2	51	0.09	7.52	0.15	37
38	0.09	2.2	51	0.09	7.52	0.15	38
39	0.09	2.2	51	0.09	7.52	0.15	39
40	0.09	2.2	51	0.09	7.52	0.15	40
41	0.09	2.2	51	0.09	7.52	0.15	41
42	0.09	2.2	51	0.09	7.52	0.15	42
43	0.09	2.2	51	0.09	7.52	0.15	43
44	0.09	2.2	51	0.09	7.52	0.15	44
45	0.09	2.2	51	0.09	7.52	0.15	45
46	0.09	2.2	51	0.09	7.52	0.15	46
47	0.09	2.2	51	0.09	7.52	0.15	47
48	0.09	2.2	51	0.09	7.52	0.15	48
49	0.09	2.2	51	0.09	7.52	0.15	49
50	0.09	2.2	51	0.09	7.52	0.15	50
51	0.09	2.2	51	0.09	7.52	0.15	51
52	0.09	2.2	51	0.09	7.52	0.15	52
53	0.09	2.2	51	0.09	7.52	0.15	53
54	0.09	2.2	51	0.09	7.52	0.15	54
55	0.09	2.2	51	0.09	7.52	0.15	55
56	0.09	2.2	51	0.09	7.52	0.15	56
57	0.09	2.2	51	0.09	7.52	0.15	57
58	0.09	2.2	51	0.09	7.52	0.15	58
59	0.09	2.2	51	0.09	7.52	0.15	59
60	0.09	2.2	51	0.09	7.52	0.15	60
61	0.09	2.2	51	0.09	7.52	0.15	61
62	0.09	2.2	51	0.09	7.52	0.15	62

FIGURE 49

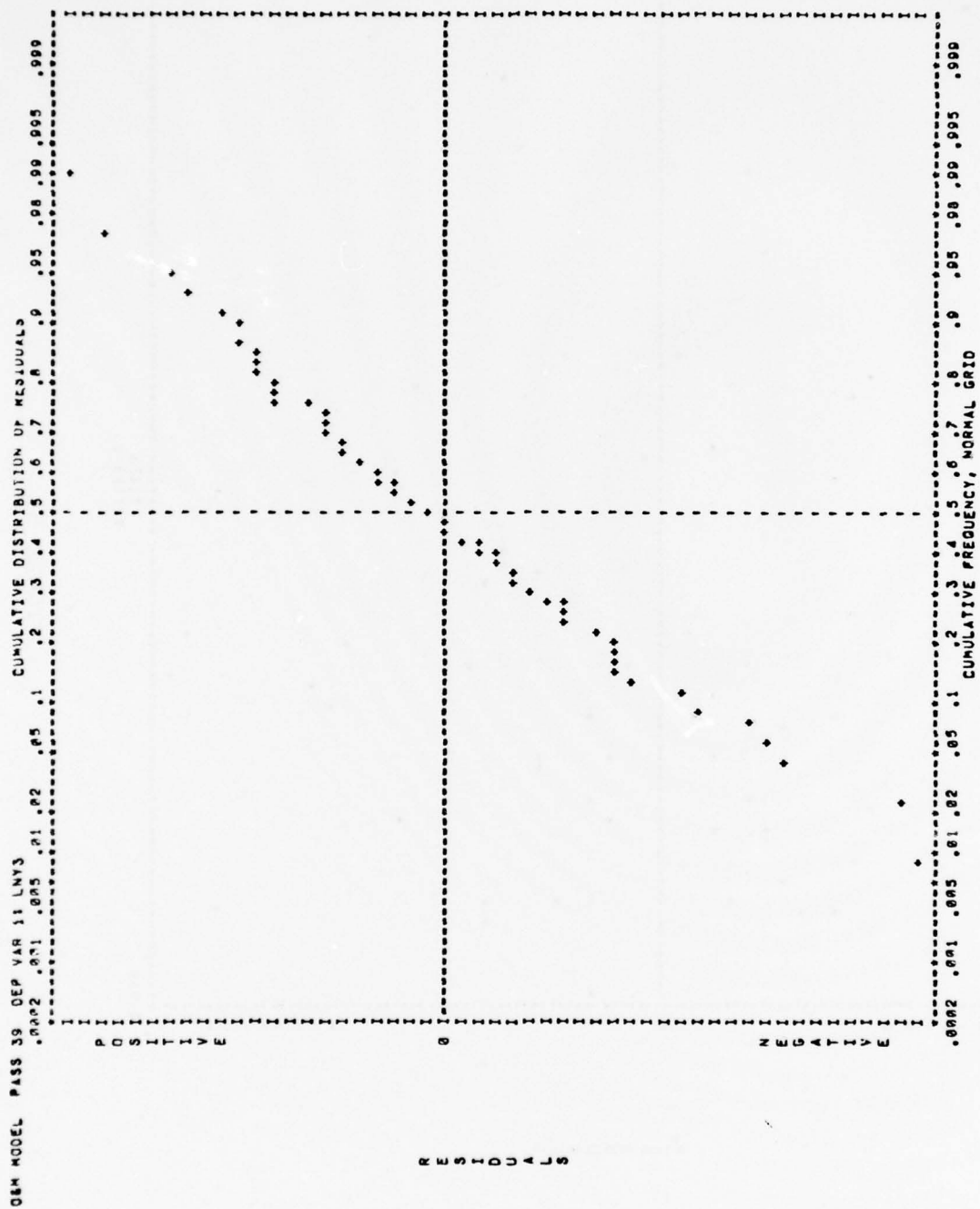


FIGURE 50

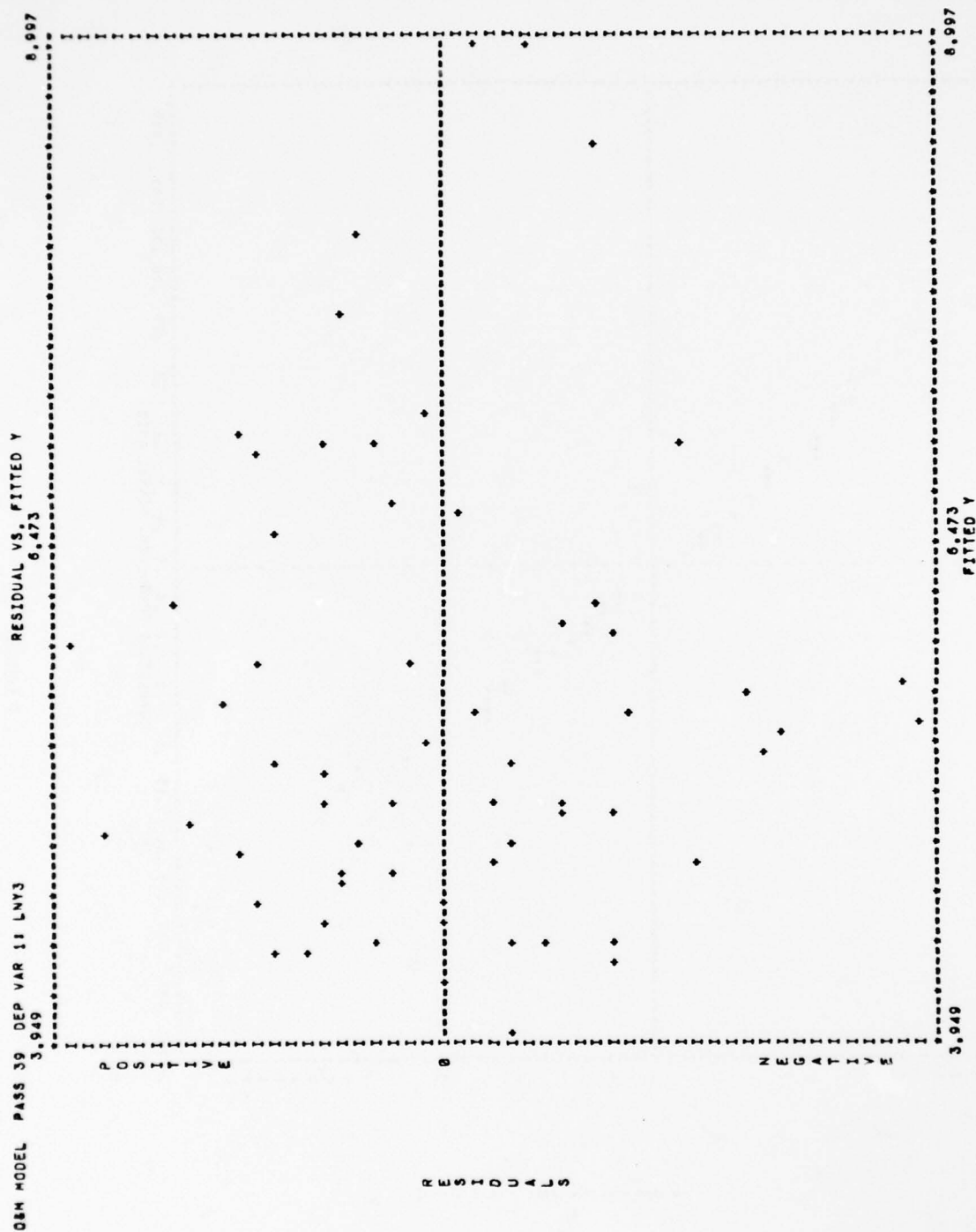


FIGURE 51

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

QRM MODEL PASS 39 DEP VAR 11 LNV3 MIN Y = 3.814D 00 MAX Y = 8.927D 00 RANGE Y = 5.109D 00

IND.VAR(I)	NAME	COEF.R(I)	S.E. COEF.	T-VALUE	R(I)SD	MIN X(I)	MAX X(I)	RANGE X(I)	REL.INF.X(I)
0		1.00376D 01							
1	X3M	2.9227D 01	1.60D 01	1.8	0.3674	-2.580D 01	7.420D 01	1.000D 00	0.06
2	X5	1.6894D 00	3.27D 01	5.2	0.2302	-2.033D 01	5.387D 01	7.420D 01	0.25
3	X6	6.52948D 01	3.32D 01	2.8	0.2117	-2.163D 01	5.735D 01	7.920D 01	0.10
4	X15	1.74549D 02	3.13D 03	5.6	0.7052	0.0	1.000D 02	1.000D 02	0.34
5	X18	5.66550D 03	2.45D 03	2.3	0.7244	0.0	1.000D 02	1.000D 02	0.11
6	X21	7.84046D 03	6.41D 03	1.2	0.5373	0.0	6.100D 01	6.100D 01	0.09
7	X10M	1.40794D 02	5.33D 03	2.6	0.6935	-3.500D 01	1.375D 02	1.725D 02	0.48
8	X10SD	-8.73262D 05	6.08D 05	1.4	0.7486	2.950D 02	1.179D 04	1.79D 04	0.20
9	X17SD	2.82277D 04	1.01D 04	2.8	0.4788	2.341D 02	3.564D 03	3.330D 03	0.13
10	X19SD	7.63690D 07	3.41D 07	2.2	0.3479	4.840D 02	8.990D 05	8.294D 05	0.12
11	LNx8	-2.37739D 01	6.26D 02	3.8	0.6618	5.063D 00	1.269D 01	7.636D 00	0.35
12	LNx10	-1.01557D 00	1.03D 01	5.5	0.0148	1.823D 01	5.157D 00	4.975D 00	0.99

NO. OF OBSERVATIONS 62
 NO. OF IND. VARIABLES 12
 RESIDUAL DEGREES OF FREEDOM 49
 F-VALUE 36.3
 RESIDUAL ROOT MEAN SQUARE 0.43229090
 RESIDUAL MEAN SQUARE 0.1687542
 RESIDUAL SUM OF SQUARES 0.15689560
 TOTAL SUM OF SQUARES 98.4712948
 MULT. CORREL. COEF. SQUARED .8988

IND.VAR(I)	NAME	COEF.B(I)	MIN X(I)	MAX X(I)	RANGE X(I)	REL.INF.X(I)
0		9.41366D 02				
1	X3M	2.49870D 01	-2.580D 01	7.420D 01	1.000D 00	0.06
2	X5	1.57000D 00	-2.033D 01	5.387D 01	7.420D 01	0.26
3	X6	6.09060D 01	-2.163D 01	5.735D 01	7.920D 01	0.11
4	X15	1.46877D 02	0.0	1.000D 02	1.000D 02	0.29
5	X18	3.02542D 03	0.0	1.000D 02	1.000D 02	0.06
6	X21	6.55120D 03	0.0	6.100D 01	6.100D 01	0.08
7	X10M	1.05812D 02	-3.500D 01	1.375D 02	1.725D 02	0.36
8	X10SD	-5.55236D 05	2.950D 02	1.179D 04	1.79D 04	0.13
9	X17SD	2.45432D 04	2.341D 02	3.564D 03	3.330D 03	0.16
10	X19SD	9.01679D 07	4.840D 02	8.990D 05	8.294D 05	0.15
11	LNx8	-1.76874D 01	5.063D 00	1.269D 01	7.636D 00	0.26
12	LNx10	-0.65240D 01	1.823D 01	5.157D 00	4.975D 00	0.94

REQUIRED X(I) PRECISION
 (DIGIT RIGHT OF DECIMAL POSITIVE,
 LEFT OF DECIMAL NEGATIVE)

IND.VAR(I)	DIGIT
1	1
2	1
3	1
4	-2
5	-2
6	-2
7	-2
8	-4
9	-4
10	-6
11	1
12	1

using the entire set of data and the statistics at the bottom are those calculated with observation 9 omitted. Here we note that the coefficient, for X18 has decreased by nearly 50%, and the coefficient for X21 has decreased by nearly 15%. Sometimes the effects of the observations on a certain coefficient are lying hidden beneath other effects, and hence the effects on the coefficients for X21 may be larger than the statistics indicate. Therefore, in addition to considering curvature for the previous variables X8, X10, X17 and X19, we consider curvature for X18 and X21. If curvature is not needed in variable X21, the C_p search technique should omit it. This exercise is shown in Figure 53. Again a fractional factorial search performed twice, yields the results in Figures 54-59.

The statistics are highly significant, $R_y^2 = .9183$ and F-VALUE = 41.5, the residuals are now evenly distributed, (indicating constant variance of $\sigma^2(y)$), the cumulative distribution is a straight line (indicating normality) and the cumulative estimates of the standard indicates that there is no evidence of lack of fit.

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

O&M MODEL PASS 41 DEP VAR 21 LNY3 MIN Y = 3.618D 8P MAX Y = 8.927D 88 RANGE Y = 5.189D P3

IND. VAR(I)	NAME	COEF. R(I)	S.E. COEF.	T-VALUE	R(I)SQD	MIN X(I)	MAX X(I)	RANGE X(I)	REL. INF. X(I)
1	X1M	1.9872D 00	0.1	0.1	0.8433	-2.740D-01	7.260D-01	1.000D 00	0.00
2	X2M	2.1810D-02	0.2	0.2	0.8433	-2.740D-01	7.260D-01	1.000D 00	0.00
3	X3M	5.2007D-02	0.6	0.6	0.6724	-2.740D-01	7.260D-01	1.000D 00	0.00
4	X4M	1.4434D-01	0.5	0.5	0.6633	-2.150D-01	7.060D-01	1.000D 00	0.00
5	X5M	1.2427D-01	4.0	4.0	0.5110	-2.150D-01	7.060D-01	1.000D 00	0.00
6	X6M	1.6634D-00	2.3	2.3	0.5112	-2.150D-01	7.060D-01	1.000D 00	0.00
7	X7M	2.2243D-01	0.5	0.5	0.6145	-2.150D-01	7.060D-01	1.000D 00	0.00
8	X8M	4.5600D-01	0.3	0.3	0.6531	-1.930D-01	7.260D-01	1.000D 00	0.00
9	X9M	2.2243D-01	0.8	0.8	0.6531	-1.930D-01	7.260D-01	1.000D 00	0.00
10	X10M	4.5600D-01	0.8	0.8	0.6531	-1.930D-01	7.260D-01	1.000D 00	0.00
11	X11M	1.9424D-01	1.6	1.6	0.6945	-1.930D-01	7.260D-01	1.000D 00	0.00
12	X12M	0.9572D-01	1.7	1.7	0.6945	-1.930D-01	7.260D-01	1.000D 00	0.00
13	X13M	1.0162D-01	2.0	2.0	0.6945	-1.930D-01	7.260D-01	1.000D 00	0.00
14	X14M	1.2162D-01	1.7	1.7	0.6945	-1.930D-01	7.260D-01	1.000D 00	0.00
15	X15M	1.0521D-01	1.7	1.7	0.6945	-1.930D-01	7.260D-01	1.000D 00	0.00
16	X16M	1.9783D-01	0.8	0.8	0.6808	-1.930D-01	7.260D-01	1.000D 00	0.00
17	X17M	2.3783D-01	0.8	0.8	0.6808	-1.930D-01	7.260D-01	1.000D 00	0.00
18	X18M	1.7555D-02	1.3	1.3	0.6838	-1.930D-01	7.260D-01	1.000D 00	0.00
19	X19M	9.8666D-02	1.6	1.6	0.6838	-1.930D-01	7.260D-01	1.000D 00	0.00
20	X20M	6.8346D-03	2.3	2.3	0.7043	-1.930D-01	7.260D-01	1.000D 00	0.00
21	X21M	2.6703D-04	3.6	3.6	0.7043	-1.930D-01	7.260D-01	1.000D 00	0.00
22	X22M	-1.8721D-03	2.1	2.1	0.6302	-1.930D-01	7.260D-01	1.000D 00	0.00
23	X23M	-1.5145D-01	0.5	0.5	0.6302	-1.930D-01	7.260D-01	1.000D 00	0.00
24	X24M	1.2245D-05	9.5	9.5	0.6302	-1.930D-01	7.260D-01	1.000D 00	0.00
25	X25M	1.2167D-04	2.1	2.1	0.6302	-1.930D-01	7.260D-01	1.000D 00	0.00
26	X26M	2.2124D-04	0.8	0.8	0.6302	-1.930D-01	7.260D-01	1.000D 00	0.00
27	X27M	7.6317D-07	2.1	2.1	0.6302	-1.930D-01	7.260D-01	1.000D 00	0.00
28	X28M	-6.9842D-04	1.2	1.2	0.6302	-1.930D-01	7.260D-01	1.000D 00	0.00
29	X29M	-3.3364D-01	1.4	1.4	0.6302	-1.930D-01	7.260D-01	1.000D 00	0.00
30	X30M	-8.2669D-01	3.2	3.2	0.6302	-1.930D-01	7.260D-01	1.000D 00	0.00
31	X31M	-5.1282D-02	0.3	0.3	0.6302	-1.930D-01	7.260D-01	1.000D 00	0.00

NO. OF OBSERVATIONS 62
 NO. OF IND. VARIABLES 31
 RESIDUAL DEGREES OF FREEDOM 31
 F-VALUE 14.8
 RESIDUAL ROOT MEAN SQUARE 0.43680387
 RESIDUAL MEAN SQUARE 0.19079762
 RESIDUAL SUM OF SQUARES 5.91472022
 TOTAL SUM OF SQUARES 96.47129940
 MULT. CORREL. COEF. SQUARED 0.9348

REQUIRED X(I) PRECISION
 (DIGIT RIGHT OF DECIMAL POSITIVE,
 LEFT OF DECIMAL NEGATIVE)

IND. VAR(I)	DIGIT
1	1
2	1
3	1
4	1
5	1
6	1
7	1
8	-3
9	-3
10	1
11	1
12	1
13	1
14	1
15	1
16	-5
17	-1
18	-1
19	-2
20	-3
21	-1
22	-10

FIGURE 53

OSM MODEL RUN 3 DEP VAR 1: LNY3
 LINEAR LEAST-SQUARES CURVE FITTING PROGRAM
 MIN Y = 3.9180 88 MAX Y = 8.9270 88 RANGE Y = 5.1890 88
 MULTIPLE REGRESSION ANALYSIS FOR THE "ALPOS" MODEL

$$LNY3 = 0(P) + 0(1)X3M + 0(2)X4M + 0(3)X5 + 0(4)X6 + 0(5)X1P + 0(6)X11$$

$$+ 0(7)X15 + 0(8)X18M + 0(9)X18D50 + 0(10)X19D50 + 0(11)X21D50$$

$$+ 0(12)LNX8 + 0(13)LNX10$$
 LNY3 = LN(MTBMA) MTBMA (MEAN TIME BETWEEN MAINTENANCE ACTIONS)

IND. VAR (I)	NAME	COEF. B (I)	S.E. COEF.	T-VALUE	R (I) SQRD	MIN X (I)	MAX X (I)	RANGE X (I)	REL. INF. X (I)
0									
1	X3M	9.858660 88	1.480-81	2.1	0.4953	-2.5880-81	7.4280-81	1.0000 88	0.06
2	X4M	3.155280-81	1.450-81	2.2	0.2875	-2.1820-81	7.0880-81	1.0000 88	0.06
3	X5	-3.135860-81	2.080-81	4.9	0.2353	-2.9330-81	5.3870-81	7.4280-81	0.21
4	X6	1.453210 88	3.840-81	2.7	0.2281	-2.1050-81	5.7350-81	7.9870-81	0.13
5	X10	0.311760-81	3.370-83	3.5	0.7888	1.2880 88	1.7370 82	1.7250 82	0.42
6	X11	1.176660-82	5.660-85	1.6	0.3614	9.0880 88	7.6380 83	7.6290 83	0.12
7	X15	0.266690-83	2.720-83	6.5	0.6766	0.0	1.0880 82	1.0880 82	0.15
8	X18M	1.768380-82	2.120-83	3.1	0.6748	-6.1880 81	3.6880 81	1.0880 82	0.13
9	X18D50	6.588370-83	6.710-85	2.8	0.2325	7.7280 81	2.7280 83	2.6490 83	0.18
10	X19D50	1.864380-84	2.830-87	2.6	0.2173	4.8480 82	8.2990 85	8.2940 85	0.12
11	X21D50	7.326610-87	3.240-84	1.5	0.3814	7.0380 81	1.1380 83	1.0590 83	0.10
12	LNX8	-4.839340-84	5.850-82	4.9	0.6882	9.8830 82	1.2690 81	7.6260 88	0.42
13	LNX10	-2.838850-81	1.110-81	7.5	0.8181	1.8230-81	5.1570 88	4.8750 88	0.82
13		-8.398660-81							

NO. OF OBSERVATIONS	NO. OF IND. VARIABLES	RESIDUAL DEGREES OF FREEDOM	F-VALUE	RESIDUAL ROOT MEAN SQUARE	RESIDUAL MEAN SQUARE	RESIDUAL SUM OF SQUARES	TOTAL SUM OF SQUARES	MULT. CORREL. COEF. SQUARED
62	13	48	41.5	0.39249151	0.15484959	7.39436816	98.47139848	0.9183

REQUIRED X (I) PRECISION	(DIGIT RIGHT OF DECIMAL POSITIVE, LEFT OF DECIMAL NEGATIVE)	IND. VAR (I)	DIGIT
1	1	1	1
2	2	2	1
3	3	3	1
4	4	4	1
5	5	5	-2
6	6	6	-4
7	7	7	-2
8	8	8	-2
9	9	9	-4
10	10	10	-6
11	11	11	-3
12	12	12	1
13	13	13	1

FIGURE 54

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM									
OBSM MODEL RUN 3			DEP VAR 11 LNYS		RESIDUAL ROOT MEAN SQUARE OF FITTED EQUATION:			0.39	
STANDARD DEVIATION ESTIMATED FROM RESIDUALS OF NEIGHBORING OBSERVATIONS (OBSERVATIONS 1 TO 4 APART IN FITTED Y ORDER).									
NO.	CUMULATIVE STD DEV	ORDERED BY WSSD			ORDERED BY FITTED Y			SEQ.	
		WSSD	OBSV.	DEL RESIDUALS	WSSD	DEL RESIDUALS	FITTED Y		
1	0.89	2.8	53	0.99	18.95	0.15	4.93	22	1
2	0.26	0.8	57	0.42	0.01	0.07	4.06	65	2
3	0.26	0.8	61	0.24	3.71	0.63	4.18	67	3
4	0.36	0.81	65	0.67	0.0	0.24	4.38	61	4
5	0.36	0.82	27	0.36	0.44	0.43	4.38	68	5
6	0.35	0.26	66	0.32	14.11	0.68	4.43	18	6
7	0.31	0.59	57	0.83	13.23	0.85	4.51	31	7
8	0.33	0.59	56	0.65	30.60	0.55	4.54	63	8
9	0.35	0.78	35	0.57	35.06	0.58	4.62	47	9
10	0.38	0.78	61	0.64	6.14	0.24	4.64	3	10
11	0.43	0.78	60	0.66	12.74	0.29	4.64	34	11
12	0.45	1.00	18	0.66	6.33	0.28	4.66	17	12
13	0.44	1.48	13	0.29	6.33	0.22	4.74	66	13
14	0.44	1.03	21	0.44	6.36	0.37	4.79	42	14
15	0.45	1.66	1	0.67	0.02	0.36	4.83	27	15
16	0.44	1.66	25	0.66	0.01	0.11	4.88	37	16
17	0.43	1.70	32	0.68	0.0	0.42	4.91	57	17
18	0.42	1.81	35	0.68	0.39	0.45	4.91	56	18
19	0.46	1.83	17	0.53	18.79	0.07	4.91	58	19
20	0.41	1.85	17	0.53	24.30	0.35	5.04	46	20
21	0.39	1.94	36	0.69	26.18	0.15	5.18	26	21
22	0.39	1.98	5	0.54	13.56	0.38	5.11	28	22
23	0.41	2.69	59	0.85	5.36	0.31	5.14	48	23
24	0.45	2.32	6	1.28	3.23	0.02	5.16	2	24
25	0.44	2.59	32	0.28	1.81	0.28	5.18	35	25
26	0.43	2.54	48	0.21	1.48	0.29	5.18	33	26
27	0.44	2.08	58	0.77	14.72	0.34	5.22	33	27
28	0.45	2.64	2	0.55	17.06	0.21	5.22	34	28
29	0.44	2.88	2	0.27	24.43	0.45	5.25	40	29
30	0.43	2.88	3	0.25	11.95	0.38	5.27	41	30
31	0.43	3.08	18	0.46	6.13	0.58	5.37	9	31
32	0.45	3.61	8	0.64	0.56	1.85	5.37	45	32
33	0.46	3.62	68	0.58	12.82	1.39	5.39	6	33
34	0.48	3.15	15	0.59	13.86	0.18	5.48	4	34
35	0.45	3.17	48	0.64	0.67	0.87	5.48	5	35
36	0.44	3.23	2	0.62	3.62	0.53	5.41	59	36
37	0.44	3.34	45	0.23	6.49	0.38	5.41	59	37
38	0.44	3.56	18	0.68	13.09	0.17	5.41	38	38
39	0.44	3.62	59	0.53	14.91	0.65	5.44	29	39
40	0.43	3.55	63	0.17	5.55	0.31	5.58	1	40
41	0.42	3.69	48	0.85	12.01	0.81	5.78	62	41
42	0.41	3.71	64	0.81	23.24	0.91	5.78	62	42
43	0.42	3.71	67	0.68	4.44	0.56	6.08	58	43
44	0.43	3.71	67	0.61	7.56	0.42	6.08	18	44
45	0.42	3.72	65	0.68	7.81	1.08	6.12	52	45
46	0.42	3.72	65	0.61	1.76	0.16	6.14	32	46
47	0.41	3.76	64	0.32	4.51	0.03	6.15	68	47
48	0.41	3.93	31	0.44	15.16	0.47	6.22	44	48
49	0.41	3.95	36	0.12	16.28	0.68	6.41	11	49
50	0.48	4.08	39	0.85	29.25	0.24	6.63	15	50
51	0.42	4.08	54	1.22	37.44	0.35	6.78	59	51
52	0.42	4.03	3	0.52	18.06	0.50	6.79	29	52
53	0.41	4.18	34	0.81	3.98	0.65	7.03	39	53
54	0.41	4.20	44	0.58	2.15	0.26	7.15	21	54
55	0.42	4.27	38	0.68	2.15	0.12	7.16	36	55
56	0.43	4.37	41	1.28	28.84	0.26	7.23	40	56
57	0.44	4.49	45	0.64	32.26	0.61	7.23	43	57
58	0.44	4.41	25	0.39	13.84	0.61	7.68	7	58
59	0.44	4.42	32	0.75	7.36	0.24	6.67	26	59
60	0.44	4.44	54	0.56	42.94	0.69	6.26	8	60
61	0.44	4.51	68	0.83	9.8	0.86	9.02	53	61
62	0.43	4.59	46	0.15	11.08	0.62	9.02	51	62

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

IDENT	DEP VAR	LNVS	ORDERED BY COMPUTER INPUT	RESIDUAL	OBSV.	OBS. Y	PITTED Y	ORDERED BY RESIDUALS	ORDERED RESID.	SEC
71820	1	1	5.896	-0.488	6	6.166	5.393	6.772	1	
71820	2	2	5.102	0.450	54	6.888	6.862	6.746	2	
71820	3	3	5.102	0.450	54	6.888	6.862	6.746	2	
71820	4	4	5.102	0.450	54	6.888	6.862	6.746	2	
71820	5	5	5.102	0.450	54	6.888	6.862	6.746	2	
71820	6	6	5.102	0.450	54	6.888	6.862	6.746	2	
71820	7	7	5.102	0.450	54	6.888	6.862	6.746	2	
71820	8	8	5.102	0.450	54	6.888	6.862	6.746	2	
71820	9	9	5.102	0.450	54	6.888	6.862	6.746	2	
71820	10	10	5.102	0.450	54	6.888	6.862	6.746	2	
71820	11	11	5.102	0.450	54	6.888	6.862	6.746	2	
71820	12	12	5.102	0.450	54	6.888	6.862	6.746	2	
71820	13	13	5.102	0.450	54	6.888	6.862	6.746	2	
71820	14	14	5.102	0.450	54	6.888	6.862	6.746	2	
71820	15	15	5.102	0.450	54	6.888	6.862	6.746	2	
71820	16	16	5.102	0.450	54	6.888	6.862	6.746	2	
71820	17	17	5.102	0.450	54	6.888	6.862	6.746	2	
71820	18	18	5.102	0.450	54	6.888	6.862	6.746	2	
71820	19	19	5.102	0.450	54	6.888	6.862	6.746	2	
71820	20	20	5.102	0.450	54	6.888	6.862	6.746	2	
71820	21	21	5.102	0.450	54	6.888	6.862	6.746	2	
71820	22	22	5.102	0.450	54	6.888	6.862	6.746	2	
71820	23	23	5.102	0.450	54	6.888	6.862	6.746	2	
71820	24	24	5.102	0.450	54	6.888	6.862	6.746	2	
71820	25	25	5.102	0.450	54	6.888	6.862	6.746	2	
71820	26	26	5.102	0.450	54	6.888	6.862	6.746	2	
71820	27	27	5.102	0.450	54	6.888	6.862	6.746	2	
71820	28	28	5.102	0.450	54	6.888	6.862	6.746	2	
71820	29	29	5.102	0.450	54	6.888	6.862	6.746	2	
71820	30	30	5.102	0.450	54	6.888	6.862	6.746	2	
71820	31	31	5.102	0.450	54	6.888	6.862	6.746	2	
71820	32	32	5.102	0.450	54	6.888	6.862	6.746	2	
71820	33	33	5.102	0.450	54	6.888	6.862	6.746	2	
71820	34	34	5.102	0.450	54	6.888	6.862	6.746	2	
71820	35	35	5.102	0.450	54	6.888	6.862	6.746	2	
71820	36	36	5.102	0.450	54	6.888	6.862	6.746	2	
71820	37	37	5.102	0.450	54	6.888	6.862	6.746	2	
71820	38	38	5.102	0.450	54	6.888	6.862	6.746	2	
71820	39	39	5.102	0.450	54	6.888	6.862	6.746	2	
71820	40	40	5.102	0.450	54	6.888	6.862	6.746	2	
71820	41	41	5.102	0.450	54	6.888	6.862	6.746	2	
71820	42	42	5.102	0.450	54	6.888	6.862	6.746	2	
71820	43	43	5.102	0.450	54	6.888	6.862	6.746	2	
71820	44	44	5.102	0.450	54	6.888	6.862	6.746	2	
71820	45	45	5.102	0.450	54	6.888	6.862	6.746	2	
71820	46	46	5.102	0.450	54	6.888	6.862	6.746	2	
71820	47	47	5.102	0.450	54	6.888	6.862	6.746	2	
71820	48	48	5.102	0.450	54	6.888	6.862	6.746	2	
71820	49	49	5.102	0.450	54	6.888	6.862	6.746	2	
71820	50	50	5.102	0.450	54	6.888	6.862	6.746	2	
71820	51	51	5.102	0.450	54	6.888	6.862	6.746	2	
71820	52	52	5.102	0.450	54	6.888	6.862	6.746	2	
71820	53	53	5.102	0.450	54	6.888	6.862	6.746	2	
71820	54	54	5.102	0.450	54	6.888	6.862	6.746	2	
71820	55	55	5.102	0.450	54	6.888	6.862	6.746	2	
71820	56	56	5.102	0.450	54	6.888	6.862	6.746	2	
71820	57	57	5.102	0.450	54	6.888	6.862	6.746	2	
71820	58	58	5.102	0.450	54	6.888	6.862	6.746	2	
71820	59	59	5.102	0.450	54	6.888	6.862	6.746	2	
71820	60	60	5.102	0.450	54	6.888	6.862	6.746	2	
71820	61	61	5.102	0.450	54	6.888	6.862	6.746	2	
71820	62	62	5.102	0.450	54	6.888	6.862	6.746	2	
71820	63	63	5.102	0.450	54	6.888	6.862	6.746	2	
71820	64	64	5.102	0.450	54	6.888	6.862	6.746	2	
71820	65	65	5.102	0.450	54	6.888	6.862	6.746	2	
71820	66	66	5.102	0.450	54	6.888	6.862	6.746	2	
71820	67	67	5.102	0.450	54	6.888	6.862	6.746	2	
71820	68	68	5.102	0.450	54	6.888	6.862	6.746	2	

FIGURE 56

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

QAM MODEL RUN 3 DEP VAR 11 LNY3

COMPONENT EFFECT OF EACH VARIABLE ON EACH OBSERVATION (IN UNITS OF Y)
(VARIABLES ORDERED BY THEIR RELATIVE INFLUENCE --- OBSERVATIONS ORDERED BY INFLUENCE OF MOST INFLUENTIAL VARIABLE)

SEQ. OBSV.	13	12	11	10	9	8	7	6	5	4	3	2	1	0	1	2
	LNX13	LNX12	LNX11	LNX10	LNX9	LNX8	LNX7	LNX6	LNX5	LNX4	LNX3	LNX2	LNX1	LNX0	X3M	X4M
1	2.51	1.12	-0.41	-0.23	-0.26	-0.13	-0.40	-0.07	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
2	2.48	0.38	-0.41	-0.23	-0.26	-0.13	-0.40	-0.07	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
3	1.64	0.52	-0.39	-0.20	-0.26	-0.13	-0.40	-0.07	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
4	1.58	0.27	-0.38	-0.20	-0.26	-0.13	-0.40	-0.07	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
5	1.54	0.27	-0.38	-0.20	-0.26	-0.13	-0.40	-0.07	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
6	0.97	0.55	-0.34	-0.16	-0.26	-0.13	-0.40	-0.07	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
7	0.97	0.51	-0.34	-0.20	-0.26	-0.13	-0.40	-0.07	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
8	0.92	-0.33	-0.33	-0.20	-0.26	-0.13	-0.40	-0.07	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
9	0.87	0.63	-0.33	-0.20	-0.26	-0.13	-0.40	-0.07	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
10	0.87	0.63	-0.33	-0.20	-0.26	-0.13	-0.40	-0.07	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
11	0.82	0.36	-0.32	-0.20	-0.26	-0.13	-0.40	-0.07	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
12	0.68	0.29	-0.32	-0.20	-0.26	-0.13	-0.40	-0.07	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
13	0.69	0.29	-0.32	-0.20	-0.26	-0.13	-0.40	-0.07	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
14	0.65	0.36	-0.30	-0.20	-0.26	-0.13	-0.40	-0.07	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
15	0.61	0.31	-0.29	-0.20	-0.26	-0.13	-0.40	-0.07	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
16	0.58	-0.49	-0.28	-0.20	-0.26	-0.13	-0.40	-0.07	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
17	0.52	0.26	-0.27	-0.20	-0.26	-0.13	-0.40	-0.07	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
18	0.45	-0.28	-0.25	-0.20	-0.26	-0.13	-0.40	-0.07	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
19	0.45	-0.25	-0.25	-0.20	-0.26	-0.13	-0.40	-0.07	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
20	0.45	-0.25	-0.25	-0.20	-0.26	-0.13	-0.40	-0.07	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
21	0.38	0.45	-0.26	-0.20	-0.26	-0.13	-0.40	-0.07	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
22	0.39	0.32	-0.25	-0.20	-0.26	-0.13	-0.40	-0.07	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
23	0.44	0.32	-0.25	-0.20	-0.26	-0.13	-0.40	-0.07	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
24	1	2.25	-0.16	-0.22	-0.24	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
25	45	-0.26	-0.13	-0.29	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
26	52	-0.16	-0.12	-0.29	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
27	58	-0.16	-0.12	-0.29	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
28	62	-0.16	-0.12	-0.29	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
29	44	-0.16	-0.12	-0.29	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
30	13	-0.19	-0.38	-0.20	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
31	14	-0.21	-0.44	-0.27	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
32	35	-0.22	-0.22	-0.26	-0.27	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
33	33	-0.25	-0.43	-0.26	-0.27	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
34	6	-0.25	-0.43	-0.26	-0.27	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
35	56	-0.32	-0.51	-0.28	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
36	37	-0.34	0.22	-0.28	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
37	6	-0.36	0.35	-0.28	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
38	2	-0.36	-0.47	-0.28	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
39	34	-0.43	-0.73	-0.29	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
40	3	-0.43	-0.73	-0.29	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
41	5	-0.43	-0.73	-0.29	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
42	46	-0.45	-0.97	-0.29	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
43	66	-0.45	-0.97	-0.29	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
44	41	-0.51	-0.98	-0.29	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
45	54	-0.53	-0.96	-0.29	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
46	62	-0.60	-0.29	-0.29	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
47	61	-0.60	-0.29	-0.29	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
48	63	-0.60	-0.29	-0.29	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
49	67	-0.60	-0.29	-0.29	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
50	65	-0.60	-0.29	-0.29	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
51	24	-0.75	-0.29	-0.29	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
52	17	-0.77	-0.24	-0.29	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
53	37	-0.77	-0.24	-0.29	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
54	37	-0.77	-0.24	-0.29	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
55	29	-0.82	-0.34	-0.29	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
56	31	-0.96	-0.29	-0.29	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
57	42	-1.06	-0.19	-0.29	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
58	28	-1.09	-0.21	-0.29	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
59	18	-1.11	-0.28	-0.29	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
60	49	-1.26	-0.67	-0.29	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
61	22	-1.34	-0.25	-0.29	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07
62	47	-1.67	-0.85	-0.29	-0.29	-0.11	-0.44	-0.04	2.14	0.06	0.18	-0.08	-0.07	-0.08	-0.08	-0.07

FIGURE 57

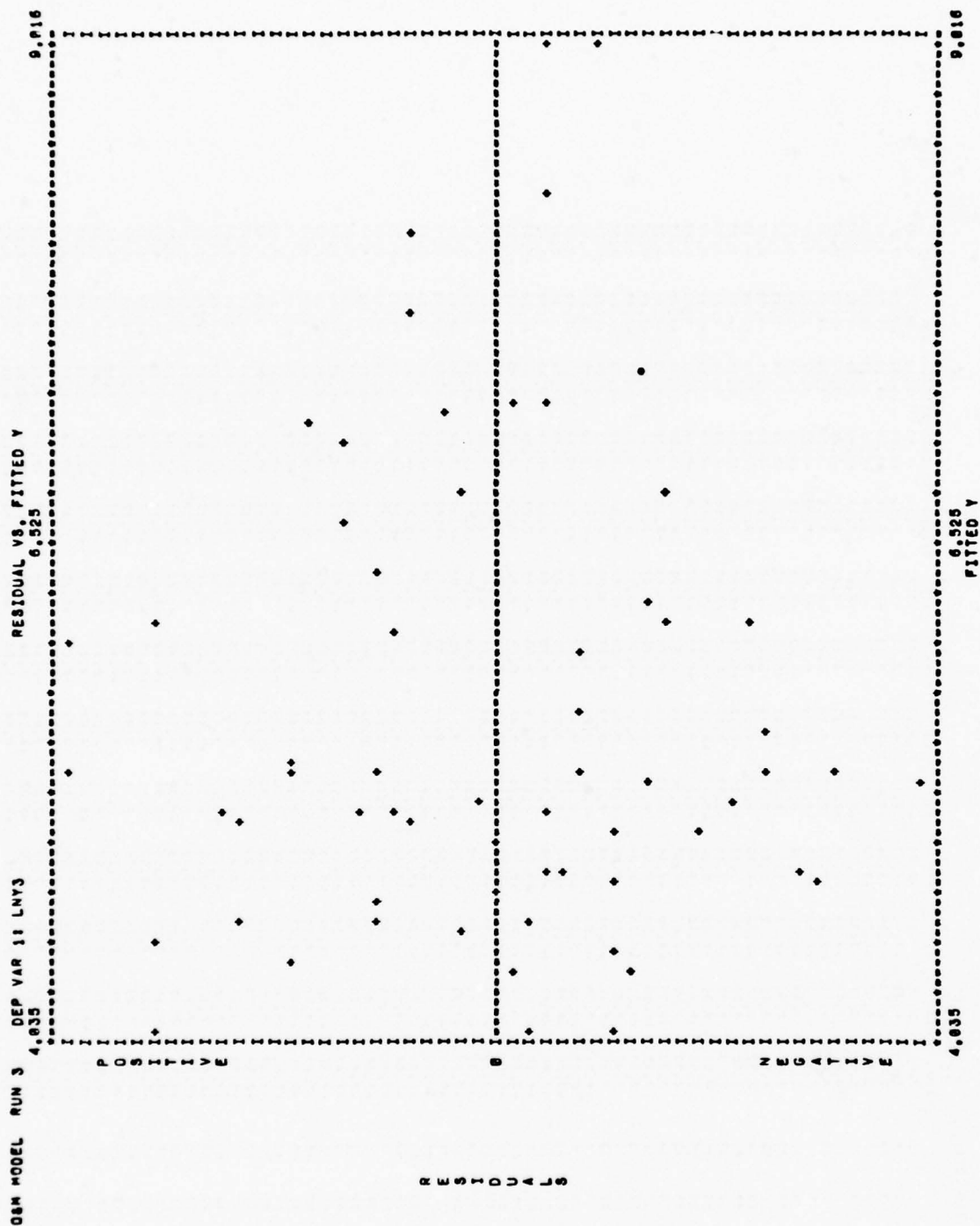


FIGURE 58

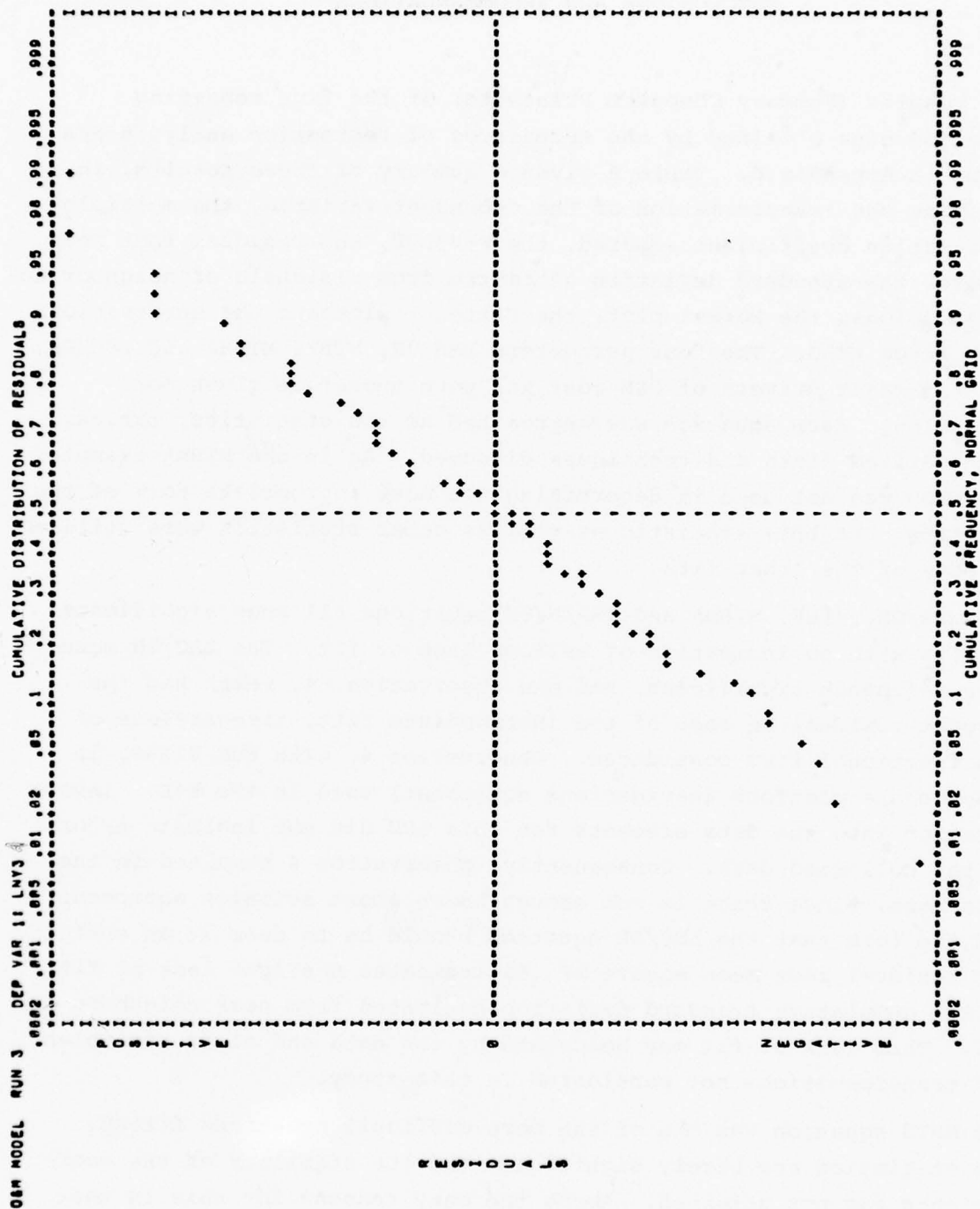


FIGURE 59

SECTION VII

CONCLUSIONS AND RECOMMENDATIONS

The results (Summary Computer Printouts) of the five remaining relationships obtained by the techniques of regression analysis are shown in Appendix B. Table 6 gives a summary of these results, indicating the transformation of the dependent variable, the multiple correlation coefficient squared, the F-VALUE, the residual root mean square, the standard deviation estimated from residuals of neighboring observations, the Normal plot, the Fitted Y plot and the observations with large WSSD. The four parameters MMH/OH, MTBF, MTBMA and LSC/OH, are the major drivers of O&M cost and were therefore given more attention. Each equation was approached as the statistics, tables, computerized plots and techniques directed. As in the MTBMA example, the WSSD was not used in determining the most appropriate form of the equation, but this statistic as well as other statistics were utilized in many of the other fits.

The MMH/OH, MTBF, MTBMA and TRAIN/OH equations all show significant results with no indication of serious lack of fit. The LSC/OH equation, although significant, had one observation, 4, which had the largest residual in each of the intermediate fits, irregardless of the functional form considered. Observation 4, with WUC 71H60, is a Gyroscope platform (navigations equipment) used in the F4E. Investigation into the data elements for this LRU did not indicate errors in the collected data. Consequently, observation 4 remained in the data base, since there is not enough known about avionics equipment and the form that the LSC/OH equation should be to deem it an outlier. The residual root mean square of .52 indicates a slight lack of fit as the cumulative standard deviation estimated from near neighbors is .57. This lack of fit may be caused by the data and other variables and transformations not considered in this study.

The NRTS equation was one of the more difficult equations fitted. The statistics are barely significant and the stability of the coefficients was not attained. Among the many reasons for this is that NRTS is highly dependent on many other factors not considered in

TABLE 6

Summary Results of the Regressions

	Transf. of. Dep. Var.	R ² _y	F-VALUE	RRMS	Cum. Std. Deviation	Normal Plot	Fitted Values Plot	WSSD
MMH/OH	None	.9005	20.5	.03	.03	OK	OK	47, 22
MTBF	ln	.9089	33.5	.42	.47	OK	OK	22
MTBMA	ln	.9183	41.5	.39	.40	OK	OK	None
LSC/OH	ln	.9283	25.3	.52	.57	4 high	4 high	45
TRAIN/OH	ln	.8599	11.7	.75	.76	OK	OK	38, 45, 46, 48
NRTS	None	.8200	6.6	15.15	7.10	20 high	20 high	None

this study (most are subjective). Leaving out influential variables can make other collections of variables appear significant when in fact they are not. Although there is a serious lack of fit in the NRTS equation, 15.5 versus 7.1, the results are still useful, since only large differences in NRTS cause significant changes in the total number of spares estimated by the EBO routine.

Because of time constraints, one area not touched upon in this study is that of "prediction intervals." The prediction intervals depend on the standard error or variance of the fitted equation. The formula for computing this variance is rather complicated and is dependent on the residual mean square, the number of observations, the i th diagonal elements of the inverse matrix and the spread of the independent variables. Although the LLSCFP does not compute this variance, we recommend the simple bounds suggested by Daniel and Wood ([1], page 55).

Another area not discussed is that of error in the independent variables (Assumption A3). Some notable contributions on the subject of error in the independent variables has been made for the case of one independent variable (See Bibliography; Acton, Hocking and Leslie, Mandansky). It appears, however, that there are no results now in the statistical literature that lend to practical applications when multiple variables are considered.

As previous experience indicates, many of the logistics, cost and support parameters considered in this study are difficult parameters to estimate, especially Field MTBF, i.e., the value actually achieved. MTBF is usually the major cost and risk driver in resource, warranty and maintenance models. MTBF is estimated from MIL-STD-217B and other reliability documents based on the proposed, detailed system configuration. But the configuration and other parameters which define MTBF are not usually well defined in the early proposal phase. Previous predictions for Field MTBF in the conceptual phase were off by several orders of magnitude, which indicates the risk involved when using these predictions.

The estimating relationships obtained in this study were put through critical statistical examinations and covered a wide range of possible functional forms. Although the results, statistical and validation (Volume I), were quite encouraging, there are still areas for improvement that warrant further study to increase the prediction capability of the equations obtained.

The first and major recommendation is to expand the data base. Although the data base used indicated that relationships did exist, more data would lend to convergence of the "true" functional forms. By expanding the data base we mean more data, more independent variables, extending the ranges of the variables and expanding to newer technology areas. Other variables, not considered in this study, that may have an influential effect on the dependent variable, should be introduced into the regressions, so as to reduce bias and improve the prediction capability of the equations. Some of the variables may not have been experienced over a range adequate enough to display their influence. Extending the ranges of the variables and using newer equipment in the data base will enhance the capability of predicting advanced equipment costs.

The second recommendation is to refine the data base. This includes investigation into other Data Collection Systems to obtain more sound and up-to-date data. Moreover, it is recommended that a panel of qualified experts on the studied equipment be formed, to determine the validity of each data element.

The third recommendation is to consider more transformation of the variables. The transformations considered covered a wide range of possible forms, but there are many other transformations that may better approximate the more complicated cases. For instance, some of the independent variables were percentages which covered a wide range of values. The Inverse Sine transformation can be used to weigh more heavily the small percentages which have small variance. In addition cross products of the variables can also be considered as viable transformations. Again there must be more data available to give the analyst the flexibility needed to consider many different functional forms.

The fourth recommendation is to consider other subset collections of the final collection of variables obtained for each equation. The C_p -search technique, in addition to finding those collections of variables which have the smallest total squared error, finds other subsets of these variables and ranks them according to their C_p -values. Sometimes these subcollections have approximately the same C_p -statistic and variance of prediction as the final collection. This will greatly enhance the flexibility of the use of the equations and the ALPOS model, in that some of the values of the more difficult to obtain variables may not be needed to make satisfactory predictions.

The fifth recommendation is to investigate the possibilities of considering Non-linear Regression Analysis as a means of determining the correct functional form of the equations. Although the relationships considered in this study covered a wide range of possible functional forms, Non-linear Regression Analyses can be used to approximate even more complicated cases.

Although many Logisticians feel that predicting Logistics costs by the techniques of Regression Analysis is not a viable approach to take (usually because of inconsistencies in the data collection systems), the statistics and validation results, however, indicate the great possibilities ahead. We feel that this study has significantly contributed to the art of estimating advanced avionics equipment costs early in the conceptual phase. The stage has been set, the statistics defined, the approach outlined, the results displayed and the recommendations made. There is a light shining across the horizon. The challenge is to reach that light.

SECTION VIII

A TECHNICAL NOTE ON REGRESSION ANALYSIS

The name Regression Analysis is associated with the names Analysis of Variance and Analysis of Covariance. There is not a very acute distinction between these three types of analyses. According to Scheffé (see Bibliography), the distinction can be made that in the analysis of variance all independent variables are qualitative, in regression analysis all independent variables are quantitative, whereas in the Analysis of Covariance the independent variables are both qualitative and quantitative. According to this slight difference, we might say that the analyses presented in this report fall under the realm of analysis of covariance. Regression analysis, however, can be used to consider all three types of problems.

Analysis of variance is used to determine if significant differences exist between the means of different populations. For instance, we may want to know if there is a significant difference between the average MTBF of equipment used in fighters and that of equipment used in bomber or cargo type aircraft. If the statistics indicate that a significant difference exists, the problem is then to find which aircraft type is "more" significantly different from the "baseline." Analysis of variance depends on different methods of comparison to determine the "least" and/or "most" significant differences. Two notable procedures that have been developed are Tukey's method and Scheffé's Method for Multiple Comparisons (See Guenther). Some recent approaches have been the Least Significant Difference and Duncan's Multiple Range Test (See Adler and Roessler).

The problem of finding the "most" significant differences becomes more difficult to disentangle when more categories are used (such as the avionics area) and interactions are considered. However, if an analysis of variance problem is solved using the statistics and techniques presented on regression analysis, much more information can be obtained. The procedure is to consider indicator (independent) variables to represent the qualitative classes (with an assumed baseline) and make a fit on the dependent variable. If the statistics

are not significant (i.e., a bad fit), we can say that there is no significant differences in the means. If the statistics indicate a significant fit, then there are some classes or interactions with significantly different means. If interactions are not among the variables admitted by the C_p -search technique (usually admits those variables with largest t-values and relative influence), then the variable which causes the most significant drop in the C_p -values gives a good indication of the class which is "most" different. If interactions prove significant, another fit is to be made with different indicator variables representing the interactive classes (with an assumed interactive baseline), and use the statistics and C_p -search technique to determine which specific interactive classes are significantly different from which others. In addition, useful information can be extracted from other statistics, tables and computerized plots, such as the coefficients of the indicator variables, the "Component Effects" Table and the component-plus-residual plots.

There are also elementary statistical hypothesis type problems, such as testing the hypothesis that the mean of a certain sample is equal to a specified value against the alternative that it is not, that can be handled by the techniques of regression analysis, if the variables are properly defined (again more information can be obtained).

Thus, we see the wide range of possible applications of Regression Analysis.

Many examples in standard statistics books as well as some advanced books on statistical hypothesis testing, analysis of variance and analysis of covariance, have been investigated. Using the approaches outlined, above, the results have been similar. The author is planning a paper in the near future showing the results of these investigations.

APPENDIX A

DATA USED

IN

REGRESSIONS

ALPOS
MULTIPLE REGRESSION ANALYSIS DATA

	BOMBER	CARGO	SENS	COMM	BOMSEN	ROMCOM	CARCOM	EM	PS	XTMR	SS	POWDIS	UFACI	BITFIT
	UPRICE	VOLUME	WEIGHT	COUNT	COENS	DIGITAL	ANALOG							
	MMH/OH	MTRE	MTBMA	LSC/OH	TRA/OH	NRTS								
1 71820	0.	0.	0.	0.	0.	0.	0.	14.00	0.00	0.00	86.00	200.	2.30	0.00
	13721.	443.	17.70	410.	0.93	0.20	86.00							
	0.034	244.	163.	0.593	0.240	13.00								
2 73530	0.	0.	0.	0.	0.	0.	0.	27.00	0.00	0.00	73.00	175.	2.30	4.00
	41034.	998.	36.60	2176.	2.10	0.20	73.00							
	0.031	400.	274.	0.694	0.000	16.00								
3 71120	0.	0.	0.	0.	0.	0.	0.	0.00	0.00	25.00	27.00	212.	2.30	0.00
	6681.	1444.	40.00	491.	0.34	0.00	75.00							
	0.051	271.	161.	0.840	0.336	27.00								
4 71060	0.	0.	0.	0.	0.	0.	0.	76.00	0.00	0.00	24.00	820.	2.30	0.00
	36913.	1676.	30.60	78.	0.05	0.00	24.00							
	0.058	209.	120.	6.068	2.253	16.00								
5 71000	0.	0.	0.	0.	0.	0.	0.	1.00	0.00	25.00	95.00	77.	2.30	0.00
	8410.	1473.	40.00	689.	0.47	0.00	74.00							
	0.049	191.	133.	1.115	0.338	11.00								
6 71080	0.	0.	0.	0.	0.	0.	0.	14.00	0.00	0.00	88.00	280.	2.30	0.00
	2241.	1276.	36.50	758.	0.59	0.00	66.00							
	0.026	672.	476.	0.407	0.136	6.00								
7 71710	0.	0.	0.	0.	0.	0.	0.	0.00	0.00	0.00	100.00	20.	2.30	1.00
	840.	91.	4.00	12.	0.13	0.00	100.00							
	0.003	4239.	2521.	0.055	0.020	9.00								
8 72400	0.	0.	0.	0.	0.	0.	0.	3.00	0.00	0.00	97.00	87.	2.30	0.00
	2055.	133.	1.25	84.	0.63	0.00	97.00							
	0.002	4653.	3540.	0.039	0.015	4.00								
9 71650	0.	0.	0.	0.	0.	0.	0.	11.00	0.00	0.00	34.00	172.	2.30	13.00
	23327.	584.	14.00	421.	0.72	0.00	89.00							
	0.032	228.	94.	0.517	0.114	0.00								
10 71000	0.	0.	0.	0.	0.	0.	0.	2.00	0.00	0.00	98.00	384.	2.30	19.00
	10090.	142.	13.90	412.	2.90	49.00	40.00							
	0.034	803.	529.	0.473	0.021	24.00								
11 71080	0.	0.	0.	0.	0.	0.	0.	67.00	0.00	0.00	33.00	175.	2.30	17.00
	18000.	424.	13.90	61.	0.14	0.00	33.00							
	0.019	945.	736.	0.000	0.213	94.00								
12 71000	0.	0.	0.	0.	0.	0.	0.	0.00	0.00	0.00	100.00	20.	2.30	13.00
	8632.	200.	6.50	150.	0.75	0.00	100.00							
	0.005	0.	0.	0.078	0.004	100.00								
13 71000	0.	0.	0.	0.	0.	0.	0.	0.00	0.00	25.00	93.00	70.	2.30	18.00
	57100.	866.	20.80	32.	0.04	0.00	75.00							
	0.064	382.	214.	1.817	0.164	11.00								
15 71450	1.	0.	0.	0.	0.	0.	0.	7.00	0.00	0.00	93.00	7.	1.30	4.00
	1102.	280.	7.50	214.	0.76	0.00	93.00							
	0.011	1288.	1000.	0.168	0.056	0.00								

ALPDS
MULTIPLE REGRESSION ANALYSIS DATA
(CONTINUED)

	BOMBER UPRICE MMW/OH	CARGO VOLUME MTBF	SENS HEIGHT MTSMA	COMM COUNT LSC/OH	BOMSEN COENS TRA/OH	BOMCOM DIGITAL NRTS	CARCOM ANALOG	EM	PS	XTMR	SS	POMDIS	UFACF	BITFIT
17 71ADA	1. 2744. 0.211	0. 1732. 116.	0. 60.00 98.	0. 924. 3.501	0. 0.53 0.696	0. 0.00 4.00	0. 100.00 0.00	0.00	0.00	0.00	0.00	17.	1.30	0.00
18 7308A	1. 5928. 0.176	0. 6478. 147.	0. 90.00 121.	0. 321. 3.028	0. 0.05 0.870	0. 0.00 8.00	0. 75.00 0.00	0.00	0.00	25.00	25.00	1040.	1.30	0.00
19 71ACC	1. 153. 0.015	0. 86. 0.	0. 2.60 0.	0. 78. 0.228	0. 0.91 0.041	0. 100.00 3.00	0. 100.00 0.00	0.00	0.00	0.00	0.00	17.	1.30	0.00
20 73C8Q	1. 158. 0.004	0. 30. 3704.	0. 1.20 3704.	0. 36. 0.095	0. 1.27 0.028	0. 100.00 100.00	0. 100.00 0.00	0.00	0.00	0.00	0.00	34.	1.30	4.00
21 73CEN	1. 2762. 0.005	0. 256. 3213.	0. 10.50 1781.	0. 20. 0.364	0. 0.07 0.697	0. 0.00 100.00	0. 0.00 0.00	100.00	0.00	0.00	0.00	100.	1.30	0.00
22 73CFK	1. 18720. 0.456	0. 8200. 60.	0. 118.00 45.	0. 561. 8.091	0. 0.06 2.015	0. 0.00 3.00	0. 75.00 0.00	0.00	0.00	25.00	66.50	152.	1.30	0.00
24 73DAM	1. 5720. 0.077	0. 3060. 361.	0. 50.00 233.	0. 156. 1.307	0. 0.05 0.443	0. 0.00 18.00	0. 43.00 0.00	57.00	0.00	0.00	0.00	225.	1.30	0.00
25 73EBA	1. 1347. 0.009	0. 132. 1102.	0. 3.40 649.	0. 120. 0.150	0. 0.91 0.037	0. 100.00 8.00	0. 100.00 0.00	0.00	0.00	0.00	0.00	34.	1.30	0.00
26 73EBF	1. 2590. 0.070	0. 464. 150.	0. 11.50 113.	0. 177. 1.333	0. 0.38 0.393	0. 0.00 24.00	0. 100.00 0.00	0.00	0.00	0.00	37.00	130.	1.30	0.00
27 71CA0	0. 3265. 0.224	1. 1734. 84.	0. 60.00 70.	0. 924. 3.566	0. 0.53 1.067	0. 0.00 4.00	0. 75.00 0.00	0.00	0.00	25.00	0.00	500.	1.20	0.00
28 72EAA	0. 3700. 0.160	1. 6478. 166.	0. 87.50 133.	0. 321. 3.113	0. 0.95 0.937	0. 0.00 16.00	0. 75.00 0.00	0.00	0.00	25.00	25.00	1640.	1.20	0.00
29 72ECA	0. 2251. 0.031	1. 4243. 593.	0. 63.38 330.	0. 4363. 0.488	0. 1.03 0.151	0. 100.00 6.00	0. 100.00 0.00	0.00	0.00	0.00	0.00	160.	1.20	0.00
31 728P0	0. 253360. 0.226	1. 2475. 144.	0. 75.00 72.	0. 4505. 26.631	0. 1.82 6.029	0. 30.00 34.00	0. 69.00 0.00	1.00	0.00	0.00	99.60	707.	1.20	4.00
32 71JAN	0. 6247. 0.090	1. 470. 314.	0. 12.00 289.	0. 1013. 0.900	0. 2.11 0.357	0. 99.00 2.00	0. 99.00 0.00	1.00	0.00	0.00	99.00	175.	1.20	0.00

ALPOS
MULTIPLE REGRESSION ANALYSIS DATA
(CONTINUED)

	ROMBER UPRICE MMH/OH	CARGO VOLUME PTEF	SENS WEIGHT MTMA	COMM COUNT LSC/OH	BOMSEN COENS TRA/OH	ROMCOM DIGITAL NETS	CARCOM ANALOG	EN	PS	XTMR	SS	POWDIS	UFAC	BITFIT
33 71L42	2. 34802. 0.105	1. 1260. 166.	0. 32.00 161.	0. 2743. 3.123	0. 2.18 0.776	0. 55.00 17.00	0. 33.00	0.00	0.00	12.00	99.60	265.	1.20	0.00
34 720N0	0. 100450. 0.457	1. 1511. 373.	0. 39.86 127.	0. 1044. 3.928	0. 0.69 0.172	0. 87.00 8.00	0. 12.00	1.00	0.00	0.00	90.70	850.	1.20	6.00
35 72AC0	0. 16793. 0.037	1. 432. 557.	0. 31.00 284.	0. 592. 0.817	0. 1.37 0.115	0. 99.00 30.00	0. 0.	1.00	0.00	0.00	99.00	851.	1.20	4.00
36 71716	0. 1268. 0.011	1. 294. 1723.	0. 7.50 1387.	0. 214. 0.150	0. 0.73 0.003	0. 100.00 4.00	0. 0.	0.00	0.00	0.00	100.00	20.	1.20	4.00
37 71310	2. 2745. 0.171	1. 1734. 122.	0. 60.00 104.	0. 924. 2.865	0. 0.53 0.528	0. 0.00 5.00	0. 75.00	0.00	0.00	25.00	0.00	500.	1.20	0.00
38 72R00	0. 1602. 0.026	1. 399. 395.	0. 14.00 272.	0. 328. 0.377	0. 0.82 0.057	0. 0.00 4.00	0. 0.	0.00	100.00	0.00	30.00	860.	1.20	0.00
39 72RR0	0. 2185. 0.005	1. 368. 2573.	0. 9.00 1486.	0. 88. 0.076	0. 0.24 0.016	0. 0.00 9.00	0. 33.00	67.00	0.00	0.00	0.00	860.	1.20	0.00
40 75932	0. 3015. 0.008	0. 94. 5853.	1. 4.00 1329.	0. 108. 0.094	0. 1.15 0.024	0. 0.00 0.00	0. 100.00	0.00	0.00	0.00	100.00	7.	2.30	0.00
41 74800	0. 10120. 0.064	0. 1609. 103.	1. 43.70 127.	0. 1126. 1.223	0. 0.70 0.452	0. 0.00 5.00	0. 61.00	39.00	0.00	0.00	61.00	212.	2.30	0.00
42 748FA	0. 15258. 0.050	0. 1377. 160.	1. 78.50 117.	0. 399. 0.765	0. 0.29 0.307	0. 0.00 25.00	0. 0.	0.00	0.00	100.00	98.00	900.	2.30	1.00
43 74810	0. 6267. 0.004	0. 577. 2130.	1. 11.00 1265.	0. 35. 0.211	0. 0.06 0.068	0. 0.00 93.00	0. 0.	0.00	100.00	0.00	0.00	430.	2.30	5.00
44 75A10	0. 2652. 0.012	0. 560. 1513.	1. 15.00 382.	0. 911. 0.122	0. 1.63 0.125	0. 100.00 0.00	0. 0.	0.00	0.00	0.00	100.00	335.	2.30	6.00
45 75G40	0. 19274. 0.148	0. 551. 308.	1. 25.00 161.	0. 1319. 2.260	0. 2.39 0.629	0. 100.00 46.00	0. 0.	0.00	0.00	0.00	100.00	1300.	0.30	0.00
46 74FF0	0. 238727. 0.050	0. 2278. 235.	1. 41.00 152.	0. 7638. 0.722	0. 3.35 0.034	0. 100.00 50.00	0. 0.	0.00	0.00	0.00	100.00	1300.	2.30	51.30

ALPOS
MULTIPLE REGRESSION ANALYSIS DATA
(CONTINUED)

	BOMBER	CARGO	SENS	COMM	BOMSEN	BOMCOM	CARCOM	EM	PS	XTHR	SS	POWDIS	UFACIT	BITFIT
	UPRICE	VOLUME	WEIGHT	CCOUNT	COENS	DIGITAL	ANALOG							
	MMH/OH	MTBF	MTRMA	LSC/OH	TRA/OH	NRTS								
47 74FAZ	0. 156220. 0.237	0. 5330. 177.	1. 173.73 108.	2. 1558. 3.825	0. 0.29 0.156	0. 0.00 15.00	0. 0.00 0.00	0.00	0.00	100.00	99.00	270.	2.30	61.00
48 74FH0	0. 46759. 0.283	0. 1866. 347.	1. 35.00 196.	0. 932. 1.202	0. 0.50 0.077	0. 0.00 18.00	0. 0.00 0.00	0.00	0.00	100.00	100.00	1620.	2.30	59.00
49 74FU0	0. 324023. 0.174	0. 3658. 262.	1. 110.00 196.	0. 18. 0.413	0. 0.00 0.173	0. 0.00 18.00	0. 0.00 0.00	0.00	0.00	0.00	0.00	400.	2.30	0.00
50 77EC0	1. 9701. 0.045	0. 1760. 445.	1. 45.00 345.	0. 946. 1.305	1. 0.54 0.228	0. 11.00 9.00	0. 0.00 0.00	5.00	0.00	0.00	94.70	350.	1.30	0.00
51 77EE0	1. 835. 0.000	0. 222. 7884.	1. 8.50 7530.	0. 9. 0.006	1. 0.04 0.006	0. 0.00 0.00	0. 0.00 0.00	0.00	0.00	0.00	0.00	100.	1.30	0.00
52 77DC0	1. 31698. 0.224	0. 1223. 959.	1. 26.40 837.	0. 1457. 0.484	1. 1.19 0.109	0. 0.00 17.00	0. 0.00 0.00	0.00	0.00	0.00	100.00	145.	1.30	0.00
53 77080	1. 835. 0.001	0. 222. 8066.	1. 8.50 6878.	0. 9. 0.014	1. 0.04 0.004	0. 0.00 75.00	0. 0.00 0.00	0.00	0.00	0.00	0.00	100.	1.30	0.00
54 73C00	0. 24642. 0.203	0. 307. 906.	1. 8.00 905.	0. 529. 0.063	0. 1.72 0.017	0. 0.00 10.00	0. 0.00 0.00	12.00	0.00	0.00	98.60	300.	0.83	0.00
55 73CG0	0. 43912. 0.017	0. 900. 914.	1. 12.00 914.	0. 53. 0.157	0. 0.06 0.172	0. 0.00 0.00	0. 0.00 0.00	0.00	0.00	0.00	0.00	60.	0.83	0.00
56 71NA0	0. 7191. 0.143	0. 1367. 122.	0. 36.70 78.	1. 1674. 2.366	1. 1.22 0.953	0. 0.00 4.80	0. 0.00 0.00	0.00	0.00	25.00	97.60	255.	2.30	0.00
57 71CU0	0. 7191. 0.203	0. 1367. 205.	0. 36.00 120.	1. 1674. 1.552	1. 1.22 0.522	0. 0.00 5.20	0. 0.00 0.00	0.00	0.00	25.00	97.60	255.	2.30	0.00
58 63AA0	0. 9865. 0.109	0. 1120. 182.	0. 29.00 124.	1. 790. 1.794	1. 0.71 0.110	0. 0.00 6.70	0. 0.00 0.00	0.00	0.00	25.00	97.00	150.	2.30	0.00
59 65AA0	0. 14271. 0.042	0. 377. 492.	0. 14.00 320.	1. 982. 1.985	1. 2.60 0.060	0. 0.00 17.20	0. 0.00 0.00	0.00	0.00	25.00	100.00	64.	2.30	0.00
60 63BA0	1. 3846. 0.252	0. 1600. 78.	0. 49.00 61.	1. 1153. 3.423	1. 0.69 0.003	0. 0.00 2.00	0. 0.00 0.00	0.00	0.00	25.00	23.00	500.	1.30	0.00

ALPOS
MULTIPLE REGRESSION ANALYSIS DATA
(CONTINUED)

	ROMSER UPRICE MMH/OH	CARGO VOLUME MTBF	SENS WEIGHT MTBMA	COMM CCOUNT LSC/OH	BOHSEN CDENS TRA/OH	BOMCOM DIGITAL NRTS	CARCOM ANALOG	EM	PS	XTMR	SS	POMDIS	UFAC	BITFIT
61 63CAA	1. 3846. 0.168	0. 1680. 96.	0. 49.00 78.	1. 1153. 2.766	0. 0.69 0.688	1. 0.00 2.00	0. 75.00 0.00	0.00	0.00	25.00	23.00	500.	1.30	0.00
62 658AA	1. 3914. 0.052	0. 1844. 305.	0. 29.00 250.	1. 1236. 0.788	0. 0.67 0.206	1. 0.00 5.70	0. 76.00 0.00	1.00	0.00	15.00	97.50	90.	1.30	5.00
63 618BA	1. 5864. 0.074	0. 1969. 203.	0. 49.00 173.	1. 1378. 1.203	0. 0.74 0.295	1. 0.00 5.40	0. 100.00 0.00	0.00	0.00	0.00	70.00	300.	1.30	0.00
64 658AA	0. 3914. 0.054	1. 1844. 254.	0. 29.00 190.	1. 1235. 0.825	0. 0.67 0.255	0. 0.00 3.00	1. 76.00 0.00	1.00	0.00	15.00	97.50	90.	1.20	5.00
65 63AF0	0. 4083. 0.000	1. 1680. 74.	0. 51.00 55.	1. 1186. 6.142	0. 0.71 0.000	0. 0.00 2.60	1. 75.00 0.00	0.00	0.00	25.00	23.00	502.	1.20	0.00
66 63AA0	0. 10712. 0.089	1. 1120. 180.	0. 41.00 139.	1. 790. 1.308	0. 0.71 0.258	0. 0.00 1.00	1. 75.00 0.00	0.00	0.00	25.00	97.00	150.	1.20	0.00
67 63121	0. 3946. 0.120	1. 1680. 126.	0. 49.00 110.	1. 1153. 1.603	0. 0.69 0.439	0. 0.00 8.10	1. 75.00 0.00	0.00	0.00	25.00	23.00	500.	1.20	0.00
68 63AAA	0. 4289. 0.030	1. 242. 360.	0. 9.00 342.	1. 1615. 0.357	0. 6.67 0.100	0. 44.00 0.00	1. 37.00 0.00	0.00	0.00	19.00	100.00	35.	1.20	0.00

APPENDIX B

RESULTS OF

THE

REGRESSION ANALYSES

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

ORAM MODEL RUN 1 DEP VAR 11 Y1 MIN V = 0.3360-E4 MAX Y = 4.9630-E1 RANGE Y = 4.9540-E1

MULTIPLE REGRESSION ANALYSIS FOR THE "ALPOS" MODEL

$$Y1 = B(2) + B(1)X5 + B(2)X6 + B(3)X7 + B(4)X13 + B(5)X18 + B(6)X9M$$

$$+ B(7)X12M + B(8)X14M + B(9)X15M + B(10)X16M + B(11)X21M$$

$$+ B(12)X90S2 + B(13)X10S3 + B(14)X140S3 + B(15)X150S3$$

$$+ B(16)X180S2 + B(17)X210S2 + B(18)X18 + B(19)X140$$

$$Y1 = MMH/20H \text{ (MAINTENANCE MANHOURS PER OPERATING HOUR)}$$

INO.VAR(I)	NAME	COEF. R(I)	S.E. COEF.	T-VALUE	R(I)SQ	MIN X(I)	MAX X(I)	RANGE X(I)	REL.INF.X(I)
0									
1	X5	-1.951150-E1	2.320-E2	1.9	0.2678	-2.1340-E1	5.3600-E1	7.4940-E1	0.07
2	X6	-4.51210-E2	2.690-E2	2.9	0.4110	-2.3170-E1	5.7630-E1	8.0800-E1	0.14
3	X7	-7.74720-E2	2.530-E2	2.6	0.3298	-2.0570-E1	5.6430-E1	8.1600-E1	0.12
4	X13	-6.49270-E2	3.510-E2	4.6	0.7724	0.0	1.0000-E2	1.0000-E2	0.36
5	X18	-1.62220-E3	1.480-E2	2.4	0.5777	0.0	1.0000-E2	1.0000-E2	0.07
6	X9M	-3.34570-E4	1.480-E2	2.4	0.5777	0.0	1.0000-E2	1.0000-E2	0.07
7	X12M	-6.61360-E5	1.220-E3	5.4	0.9534	-1.4880-E3	6.7620-E3	8.1740-E3	1.19
8	X14M	-4.62870-E3	6.610-E4	7.0	0.9572	-3.3480-E1	1.3670-E2	1.7250-E2	1.75
9	X15M	-1.87570-E3	3.490-E4	5.4	0.9117	-8.2720-E1	3.7300-E1	1.0000-E2	0.41
10	X16M	-1.20820-E3	3.440-E4	3.5	0.9817	-1.6000-E1	9.6970-E1	1.0000-E2	0.26
11	X21M	-1.54360-E3	4.970-E4	3.8	0.7162	-3.4320-E0	9.6970-E1	1.0000-E2	0.34
12	X90S2	-1.24920-E3	5.390-E4	2.3	0.6935	-4.8380-E0	6.1670-E1	6.1670-E1	0.17
13	X10S3	-1.78110-E0	2.450-E0	7.0	0.8466	6.1810-E4	2.3940-E7	2.3940-E7	0.69
14	X140S3	-1.29280-E5	5.210-E0	2.5	0.8362	1.2490-E0	1.1950-E4	1.1950-E4	0.34
15	X150S3	-3.33810-E5	0.140-E0	5.4	0.5764	4.8920-E2	2.5810-E3	2.5810-E3	0.19
16	X160S3	-3.56820-E5	7.930-E0	4.5	0.4176	5.4740-E1	7.6730-E3	2.6180-E3	0.22
17	X210S2	-8.36870-E5	3.910-E3	2.1	0.4329	1.7580-E3	2.5170-E3	7.6730-E3	0.14
18	LX9	5.78160-E5	2.760-E3	2.1	0.4833	6.2880-E1	1.1610-E3	1.0000-E3	0.14
19	LX18	-4.981970-E2	1.830-E2	4.1	0.9869	3.4810-E0	9.6120-E0	9.6120-E0	0.92
			1.070-E2	2.5	0.9872	1.8230-E1	5.1570-E0	4.9750-E0	0.54

NO. OF OBSERVATIONS 63
 NO. OF IND. VARIABLES 19
 RESIDUAL DEGREES OF FREEDOM 43
 F-VALUE 29.5
 RESIDUAL ROOT MEAN SQUARE 0.83915483
 RESIDUAL MEAN SQUARE 0.69998927
 RESIDUAL SUM OF SQUARES 0.63998942
 TOTAL SUM OF SQUARES 0.39298330
 MULTI. CORREL. COEF. SQUARED 0.9885

REQUIRED X(I) PRECISION
 (DIGIT RIGHT OF DECIMAL POSITIVE,
 LEFT OF DECIMAL NEGATIVE)

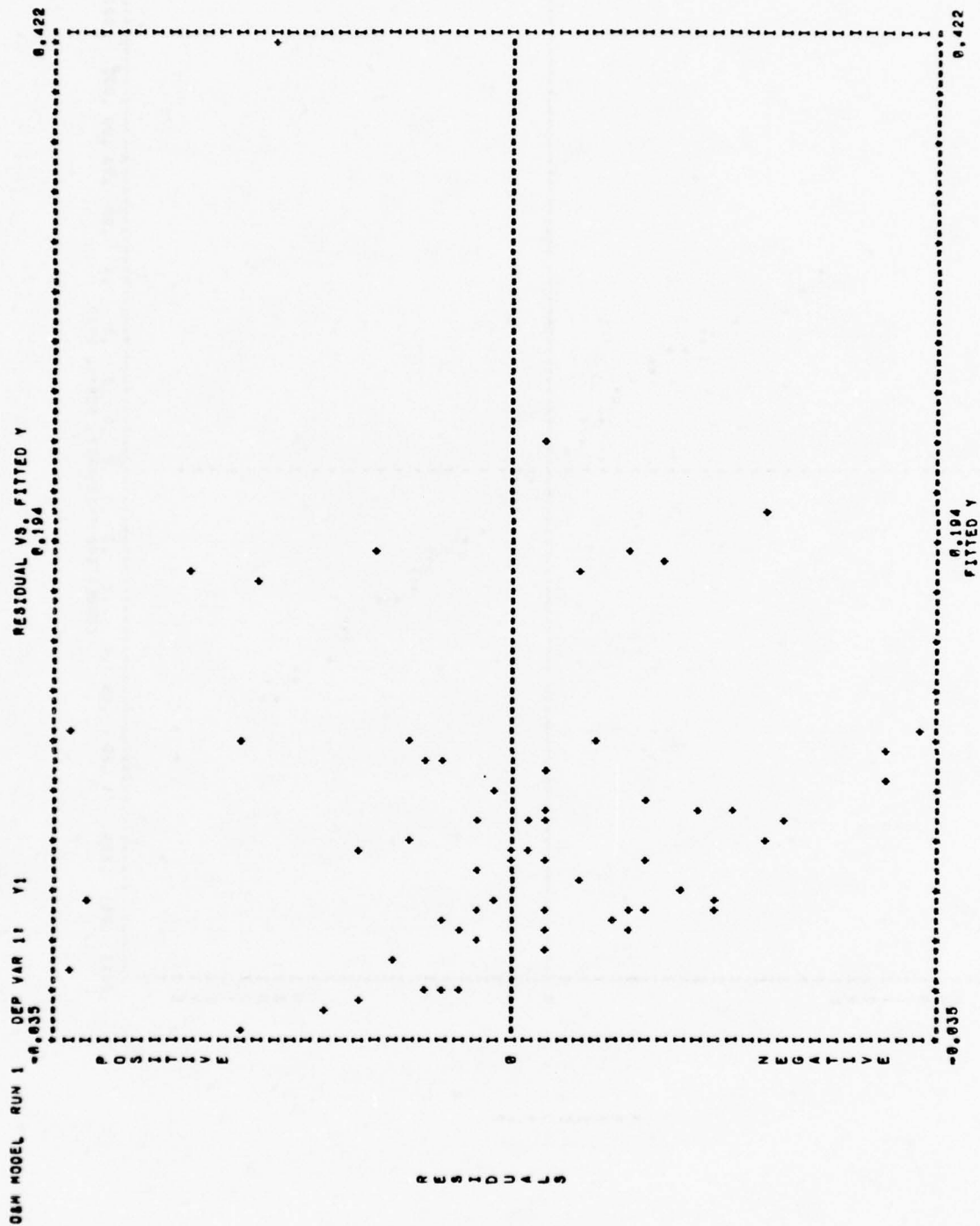
INO.VAR(I)	DIGIT
1	1
2	1
3	1
4	-2
5	-2
6	-3
7	-2
8	-2
9	-2
10	-2
11	-2
12	-7
13	-4
14	-4
15	-4
16	-3
17	-3
18	1
19	1

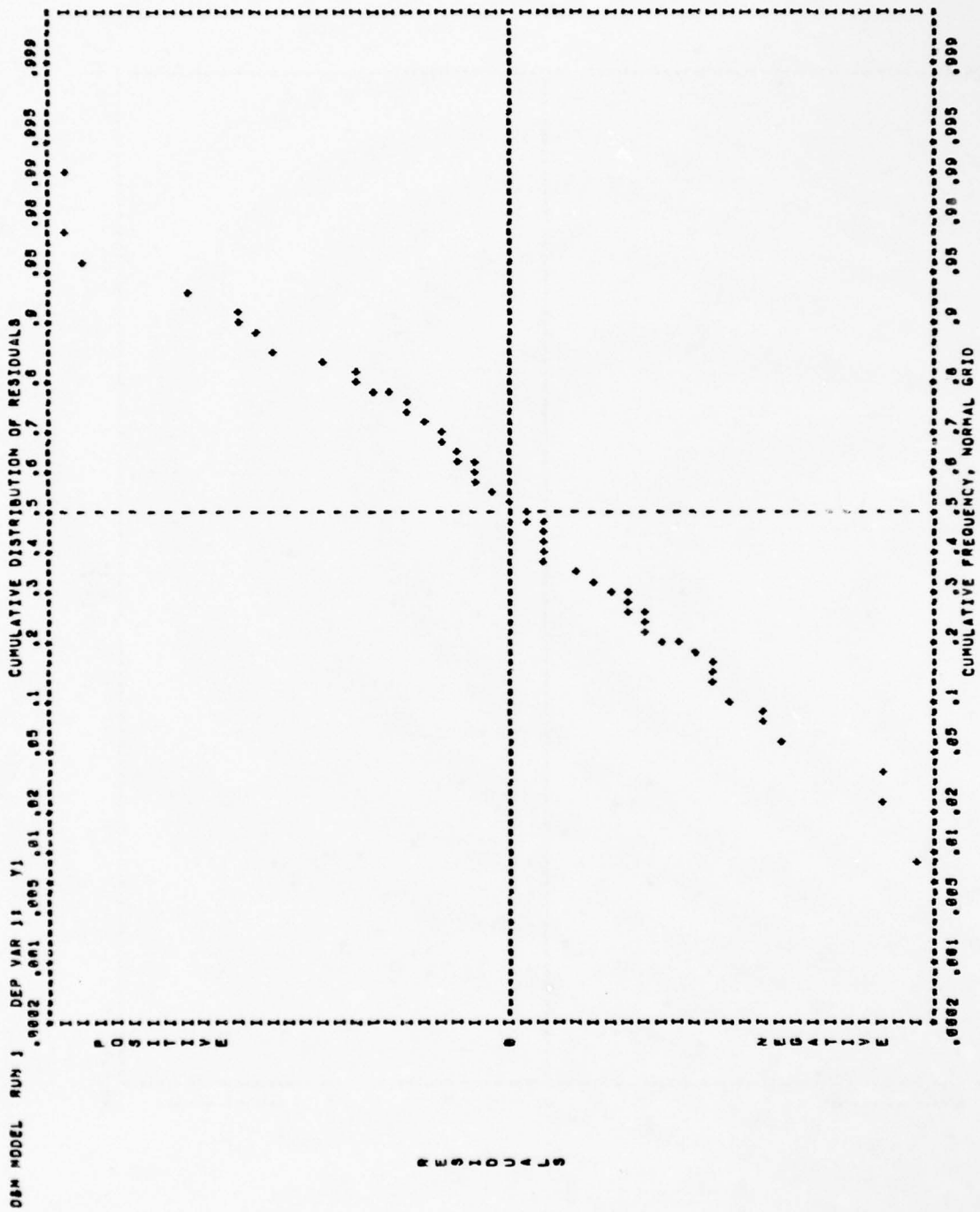
Q:M	MODEL	RUN	DEP	VAR	IS	Y1
1	1	1	1	1	1	1

[illegible]

OSM MODEL RUN 1 DEP VAR 11 Y1 LINEAR LEAST-SQUARES CURVE FITTING PROGRAM 0.03
 STANDARD DEVIATION ESTIMATED FROM RESIDUALS OF NEIGHBORING OBSERVATIONS (OBSERVATIONS 1 TO 4 APART IN FITTED Y ORDER).

NO.	CUMULATIVE STD DEV	MSO OBSV.	Y1	RESIDUAL	ROOT MEAN SQUARE OF FITTED EQUATION	0.03	SEQ.
1	0.00	37	27	0.01	0.01	0.01	1
2	0.00	51	60	0.02	0.01	0.01	2
3	0.00	57	50	0.03	0.01	0.01	3
4	0.00	53	51	0.00	0.00	0.01	4
5	0.00	7	40	0.01	0.00	0.01	5
6	0.00	29	16	0.01	0.01	0.01	6
7	0.00	44	32	0.01	0.01	0.01	7
8	0.00	3	56	0.00	0.00	0.01	8
9	0.00	54	36	0.00	0.01	0.01	9
10	0.00	219	56	0.00	0.01	0.01	10
11	0.00	219	56	0.00	0.01	0.01	11
12	0.00	219	56	0.00	0.01	0.01	12
13	0.00	219	56	0.00	0.01	0.01	13
14	0.00	219	56	0.00	0.01	0.01	14
15	0.00	219	56	0.00	0.01	0.01	15
16	0.00	219	56	0.00	0.01	0.01	16
17	0.00	219	56	0.00	0.01	0.01	17
18	0.00	219	56	0.00	0.01	0.01	18
19	0.00	219	56	0.00	0.01	0.01	19
20	0.00	219	56	0.00	0.01	0.01	20
21	0.00	219	56	0.00	0.01	0.01	21
22	0.00	219	56	0.00	0.01	0.01	22
23	0.00	219	56	0.00	0.01	0.01	23
24	0.00	219	56	0.00	0.01	0.01	24
25	0.00	219	56	0.00	0.01	0.01	25
26	0.00	219	56	0.00	0.01	0.01	26
27	0.00	219	56	0.00	0.01	0.01	27
28	0.00	219	56	0.00	0.01	0.01	28
29	0.00	219	56	0.00	0.01	0.01	29
30	0.00	219	56	0.00	0.01	0.01	30
31	0.00	219	56	0.00	0.01	0.01	31
32	0.00	219	56	0.00	0.01	0.01	32
33	0.00	219	56	0.00	0.01	0.01	33
34	0.00	219	56	0.00	0.01	0.01	34
35	0.00	219	56	0.00	0.01	0.01	35
36	0.00	219	56	0.00	0.01	0.01	36
37	0.00	219	56	0.00	0.01	0.01	37
38	0.00	219	56	0.00	0.01	0.01	38
39	0.00	219	56	0.00	0.01	0.01	39
40	0.00	219	56	0.00	0.01	0.01	40
41	0.00	219	56	0.00	0.01	0.01	41
42	0.00	219	56	0.00	0.01	0.01	42
43	0.00	219	56	0.00	0.01	0.01	43
44	0.00	219	56	0.00	0.01	0.01	44
45	0.00	219	56	0.00	0.01	0.01	45
46	0.00	219	56	0.00	0.01	0.01	46
47	0.00	219	56	0.00	0.01	0.01	47
48	0.00	219	56	0.00	0.01	0.01	48
49	0.00	219	56	0.00	0.01	0.01	49
50	0.00	219	56	0.00	0.01	0.01	50
51	0.00	219	56	0.00	0.01	0.01	51
52	0.00	219	56	0.00	0.01	0.01	52
53	0.00	219	56	0.00	0.01	0.01	53
54	0.00	219	56	0.00	0.01	0.01	54
55	0.00	219	56	0.00	0.01	0.01	55
56	0.00	219	56	0.00	0.01	0.01	56
57	0.00	219	56	0.00	0.01	0.01	57
58	0.00	219	56	0.00	0.01	0.01	58
59	0.00	219	56	0.00	0.01	0.01	59
60	0.00	219	56	0.00	0.01	0.01	60
61	0.00	219	56	0.00	0.01	0.01	61
62	0.00	219	56	0.00	0.01	0.01	62
63	0.00	219	56	0.00	0.01	0.01	63





QRM MODEL RUN 2 DEP VAR IF LNY2 MIN Y = 4.091D 00 MAX Y = 8.995D 00 RANGE Y = 4.904D 00

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

MULTIPLE REGRESSION ANALYSIS FOR THE "ALPOS" MODEL

$LN2 = 8(0) + 8(1)X3M + 8(2)X4M + 8(3)X5 + 8(4)X6 + 8(5)X15 + 8(6)X9M$
 $+ 8(7)X18M + 8(8)X9DSC + 8(9)X13DSC + 8(10)X18DSC + 8(11)X21DSC$
 $+ 8(12)LNK8 + 8(13)LNK9 + 8(14)LNK10$
 $LN2 = LN(MTBF) MTBF (MEAN TIME BETWEEN FAILURE)$

IND. VAR (I)	NAME	COEF. B(I)	S.E. COEF.	T-VALUE	R(1)30RD	MIN X(I)	MAX X(I)	RANGE X(I)	REL. INF. X(I)
0		1.36551D 01							
1	X3M	3.46241D-01	1.56D-01	2.1	0.4324	-2.380D-01	7.420D-01	1.000D 00	0.07
2	X4M	-4.58243D-01	1.59D-01	2.9	0.3118	-2.180D-01	7.910D-01	1.000D 00	0.09
3	X5	1.13374D 00	3.24D-01	3.6	0.2538	-2.333D-01	5.387D-01	7.420D-01	0.17
4	X6	6.34763D-01	3.27D-01	1.9	0.2258	-2.165D-01	5.735D-01	7.990D-01	0.12
5	X15	1.72434D-02	2.85D-03	6.1	0.0588	0.0	1.00D 02	1.00D 02	0.35
6	X9M	3.79188D-04	9.66D-05	3.9	0.0823	-1.454D 03	6.710D 03	8.170D 03	0.63
7	X18M	9.88245D-03	2.37D-03	4.2	0.0977	-6.180D 01	3.980D 01	1.000D 02	0.20
8	X9DSC	-6.18807D-08	2.67D-08	2.3	0.7488	7.673D 04	2.365D 07	2.357D 07	0.38
9	X13DSC	2.09766D-04	1.18D-04	1.8	0.2238	8.664D-01	3.240D 03	3.239D 03	0.14
10	X18DSC	1.88349D-04	7.71D-05	2.4	0.3245	7.726D 01	2.726D 03	2.649D 03	0.10
11	X21DSC	-5.92664D-04	3.43D-04	1.7	0.2768	7.039D 01	1.130D 03	1.859D 03	0.13
12	LNK8	-2.38565D-01	6.07D-02	3.9	0.0555	5.063D 00	1.260D 01	7.626D 00	0.37
13	LNK9	-6.25853D-01	2.16D-01	2.9	0.0922	3.481D 00	9.012D 03	5.611D 00	0.72
14	LNK10	-4.68888D-01	1.62D-01	2.9	0.0953	1.823D-01	5.137D 04	4.975D 00	0.47

NO. OF OBSERVATIONS 62

NO. OF IND. VARIABLES 14

RESIDUAL DEGREES OF FREEDOM 47

F-VALUE 33.5

RESIDUAL ROOT MEAN SQUARE 0.42296907

RESIDUAL MEAN SQUARE 0.17896283

RESIDUAL SUM OF SQUARES 8.48843324

TOTAL SUM OF SQUARES 92.2872250

MULT. CORREL. COEF. SQUARED .9889

REQUIRED X(I) PRECISION
(DIGIT RIGHT OF DECIMAL POSITIVE,
LEFT OF DECIMAL NEGATIVE)

IND. VAR (I)	DIGIT
1	1
2	1
3	1
4	1
5	-2
6	-4
7	-2
8	-7
9	-4
10	-4
11	-3
12	1
13	1
14	1

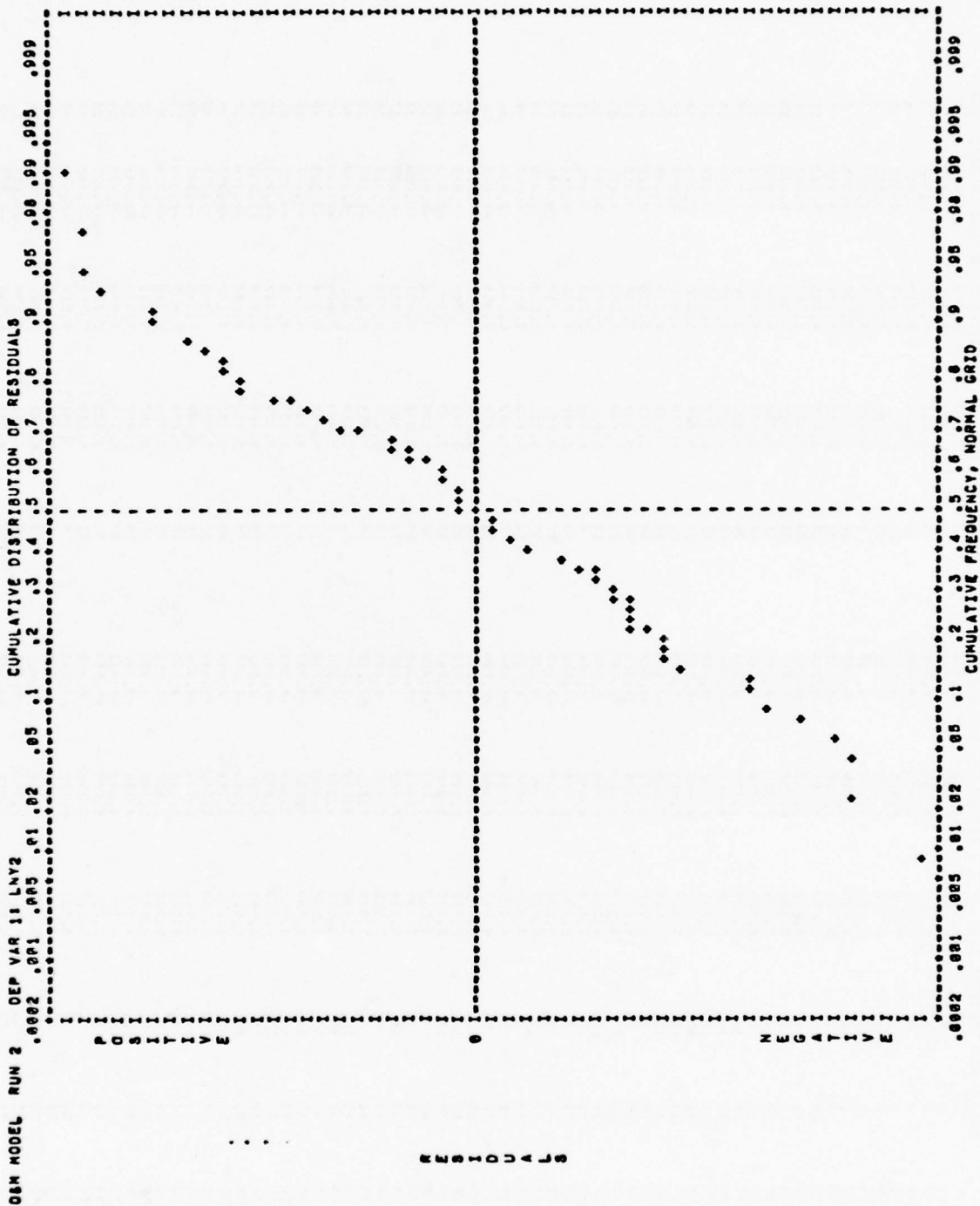
OLS MODEL RUN 2 DEP VAR 11 LNY2 RESIDUAL ROOT MEAN SQUARE OF FITTED EQUATIONS 1 0.42
 STANDARD DEVIATION ESTIMATED FROM RESIDUALS OF NEIGHBORING OBSERVATIONS (OBSERVATIONS 1 TO 4 APART IN FITTED Y ORDER).

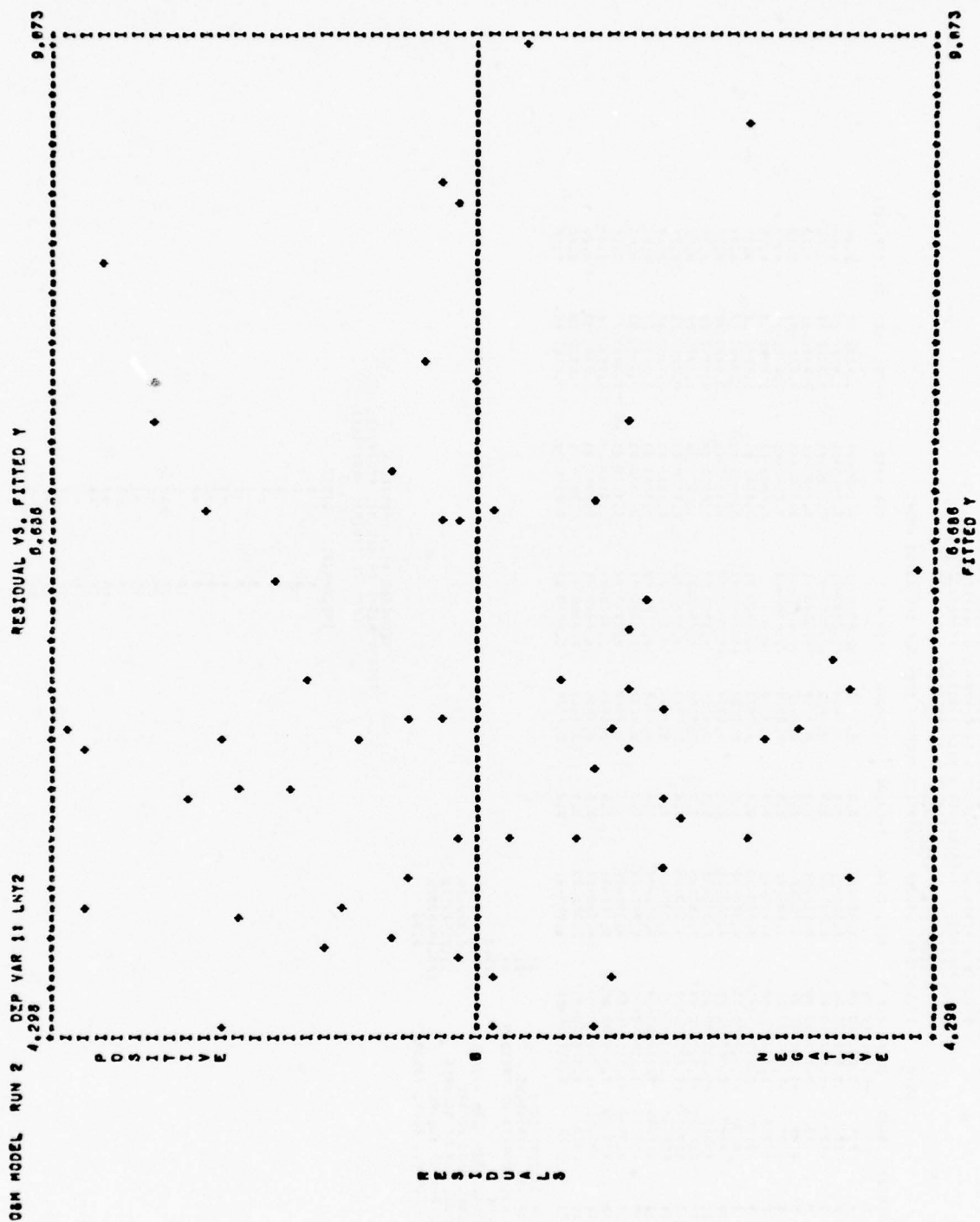
NO.	CUMULATIVE		ORDERED BY MSSD		ORDERED BY FITTED Y		SEQ.
	STD DEV	OBSV.	OBSV.	DEL RESIDUALS	DEL RESIDUALS	OBSV.	
1	0.22	53	51	53.38	0.17	4.38	1
2	0.28	56	56	0.52	0.49	4.35	2
3	0.25	61	69	0.21	1.98	4.36	3
4	0.32	65	67	0.40	0.0	4.59	4
5	0.32	27	37	0.34	3.43	4.59	5
6	0.38	66	58	0.17	24.55	4.71	6
7	0.32	58	58	0.42	26.87	4.74	7
8	0.29	58	57	0.89	9.58	4.81	8
9	0.27	15	36	0.15	3.60	4.89	9
10	0.26	1	32	0.16	26.39	4.93	10
11	0.32	35	1	0.98	27.19	4.95	11
12	0.35	68	63	0.85	8.84	5.06	12
13	0.38	50	52	0.67	8.61	5.18	13
14	0.44	32	44	1.27	8.57	5.14	14
15	0.46	48	7	0.65	2.65	5.26	15
16	0.51	3	27	1.34	2.91	5.27	16
17	0.52	42	48	0.64	8.8	5.28	17
18	0.55	3	37	1.61	32.69	5.38	18
19	0.59	6	5	1.20	49.96	5.28	19
20	0.68	67	68	0.68	12.55	5.37	20
21	0.69	67	61	0.47	4.77	5.45	21
22	0.57	65	66	0.19	3.64	5.48	22
23	0.55	65	61	0.82	2.23	5.56	23
24	0.55	48	46	0.57	11.68	5.53	24
25	0.55	35	45	0.55	27.44	5.63	25
26	0.54	64	5	0.32	18.64	5.69	26
27	0.52	7	8	0.84	7.17	5.71	27
28	0.51	34	48	0.11	5.42	5.73	28
29	0.51	25	29	0.42	15.00	5.75	29
30	0.51	17	3	0.63	3.38	5.76	30
31	0.58	66	33	0.16	3.66	5.78	31
32	0.68	58	33	0.81	2.93	5.78	32
33	0.68	45	32	0.52	14.58	5.82	33
34	0.68	1	45	0.36	26.71	5.84	34
35	0.68	21	43	0.47	54.14	5.85	35
36	0.67	65	17	0.68	36.20	5.89	36
37	0.67	67	17	0.41	16.65	5.99	37
38	0.68	59	21	0.68	29.48	6.08	38
39	0.67	54	54	0.61	5.49	6.03	39
40	0.67	34	46	0.68	1.88	6.04	40
41	0.67	33	56	0.43	2.69	6.12	41
42	0.66	33	57	0.68	10.78	6.12	42
43	0.66	5	62	0.38	1.66	6.41	43
44	0.66	44	15	0.34	6.52	6.41	44
45	0.65	2	34	0.58	2.77	6.58	45
46	0.65	42	34	0.75	13.65	6.58	46
47	0.65	45	54	0.29	13.51	6.79	47
48	0.65	48	8	0.61	25.58	6.84	48
49	0.65	25	38	0.27	33.21	6.86	49
50	0.67	33	41	1.22	4.98	6.89	50
51	0.67	54	44	0.40	2.27	7.01	51
52	0.66	61	17	0.68	15.17	7.26	52
53	0.65	68	17	0.27	2.70	7.29	53
54	0.65	57	42	0.37	23.10	7.44	54
55	0.65	58	42	0.15	85.48	7.46	55
56	0.65	2	9	0.71	31.18	7.50	56
57	0.65	56	7	0.62	1.78	8.81	57
58	0.66	6	64	0.97	2.22	8.84	58
59	0.65	63	3	0.25	12.66	8.84	59
60	0.65	9	13	0.41	35.53	8.84	60
61	0.65	39	43	0.46	8.6	9.07	61
62	0.65	63	66	0.38	53.52	9.07	62

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

OSM MODEL RUN 2 DEP VAR 11 LNY2

IDENT.	OSBY.	MS DISTANCE	OSBY.	ORDERED BY COMPUTER INPUT	FITTED Y	RESIDUAL	OSBY.	ORDERED BY RESIDUALS	FITTED Y	ORDERED RESID.	SEQ
71R2	1	3.	5.466	6.117	-0.628	6	0.510	5.779	0.730	1	
7330	2	2.	5.992	5.483	0.509	29	6.309	5.665	0.683	2	
71L8	3	3.	5.684	4.930	0.673	3	5.684	4.930	0.673	3	
71M0	4	9.	5.344	6.993	-0.659	40	6.675	6.710	0.665	4	
71K8	5	4.	5.252	5.816	-0.564	21	6.211	7.443	0.568	5	
71P8	6	2.	6.518	5.779	0.730	39	7.289	7.289	0.563	6	
7178	7	20.	6.352	6.334	0.018	2	5.992	5.483	0.523	7	
7246	8	22.	6.445	6.398	0.047	44	7.322	6.837	0.485	8	
71G8	9	3.	5.428	5.626	-0.198	59	6.109	5.747	0.452	9	
71F8	10	12.	6.698	6.891	-0.193	67	4.836	4.385	0.452	10	
71F8	11	11.	6.892	6.788	0.104	34	5.922	5.497	0.425	11	
71O8	13	3.	5.945	5.730	0.215	63	5.312	4.893	0.425	12	
71A8	15	8.	7.151	7.113	0.038	52	6.866	6.580	0.366	13	
71A8	17	6.	4.751	4.718	0.033	48	5.830	5.532	0.318	14	
7308	18	33.	4.908	4.736	0.172	35	6.322	6.038	0.284	15	
73C0	20	45.	6.217	6.084	-0.133	18	4.998	4.738	0.254	16	
73C4	21	20.	6.011	7.443	0.568	47	5.177	4.948	0.229	17	
73C8	22	59.	4.891	4.598	-0.293	13	5.945	5.730	0.215	18	
73D4	24	13.	5.898	5.835	0.063	31	4.970	4.826	0.164	19	
73E8	25	16.	7.085	7.280	-0.195	15	7.161	7.013	0.148	20	
73E8	26	4.	5.807	5.372	0.435	38	5.978	5.853	0.125	21	
71C8	27	5.	4.431	5.100	-0.669	66	5.103	5.078	0.025	22	
72E4	28	33.	5.118	5.192	-0.074	43	7.664	7.562	0.102	23	
72E4	29	17.	6.359	5.685	0.673	11	6.852	6.788	0.064	24	
72B8	31	11.	4.970	4.878	0.092	8	6.445	6.398	0.047	25	
71J8	32	3.	5.751	6.533	-0.782	24	5.890	5.835	0.055	26	
71L8	33	3.	5.226	5.270	-0.044	17	4.751	4.710	0.041	27	
72M8	34	5.	5.922	5.497	0.425	57	5.322	5.282	0.040	28	
72C0	35	4.	6.322	6.038	0.284	54	6.089	6.040	0.049	29	
7178	36	6.	7.452	7.456	-0.004	7	6.332	6.334	0.002	30	
7130	37	6.	4.607	5.141	-0.534	36	7.452	7.456	0.004	31	
72B8	38	5.	5.978	5.853	0.125	61	4.566	4.588	-0.022	32	
72B8	39	11.	7.853	7.899	-0.046	65	4.389	4.382	0.007	33	
7398	40	19.	6.675	6.618	0.056	59	6.818	6.861	-0.043	34	
7408	41	4.	5.264	5.756	-0.492	33	5.286	5.270	0.016	35	
74B8	42	4.	5.123	5.449	-0.326	58	5.282	5.257	0.025	36	
74B8	43	16.	7.664	7.562	0.102	53	6.995	6.973	0.022	37	
76A8	44	4.	7.322	6.927	0.395	51	6.973	6.973	0.000	38	
76G8	45	4.	5.987	6.251	-0.264	60	5.806	6.028	-0.222	39	
74F8	46	18.	5.458	5.214	0.244	28	5.118	5.022	0.096	40	
74F8	47	29.	5.177	4.848	0.329	9	5.428	5.020	0.408	41	
74F8	48	5.	5.856	5.532	0.324	10	6.686	6.591	0.095	42	
74F8	49	31.	5.560	5.893	-0.334	22	4.891	4.298	0.593	43	
77E8	50	6.	6.897	6.489	0.408	60	4.337	4.588	-0.251	44	
77E8	51	25.	6.973	6.873	0.100	64	5.539	5.782	-0.243	45	
77O8	52	5.	6.666	6.580	0.086	46	5.436	5.714	-0.278	46	
77O8	53	25.	6.995	6.973	0.022	62	5.732	5.986	-0.254	47	
73C8	54	7.	6.808	6.781	0.027	45	5.937	6.251	-0.314	48	
73C8	55	16.	6.818	6.681	0.137	25	7.895	7.580	0.315	49	
71M8	56	3.	4.803	5.282	-0.479	50	6.897	6.486	0.411	50	
71O8	57	3.	5.322	5.282	0.040	49	5.509	5.693	-0.184	51	
6348	58	2.	5.282	5.257	0.025	42	5.123	5.449	-0.326	52	
6348	59	5.	6.109	5.747	0.362	37	4.867	5.141	-0.273	53	
63C4	60	5.	4.337	4.588	-0.251	20	5.937	5.372	0.565	54	
63C4	61	5.	4.566	4.680	-0.114	28	6.217	6.684	-0.467	55	
63C4	62	5.	5.722	5.586	0.136	41	4.833	5.282	-0.449	56	
61B8	63	5.	5.312	4.903	0.409	41	5.284	5.556	-0.272	57	
63B8	64	4.	5.538	5.782	-0.244	5	5.232	5.516	-0.284	58	
6348	65	4.	4.309	4.332	0.023	1	5.486	6.117	-0.630	59	
6348	66	3.	5.193	5.678	-0.485	4	5.344	6.863	-1.519	60	
6318	67	4.	4.806	4.365	0.441	27	4.431	5.188	-0.757	61	
6344	68	0.	5.866	6.628	-0.762	32	5.751	6.533	-0.782	62	





OSM MODEL RUN 4 DEP VAR 11 LNYA
 MIN Y = -5.0000 R0 MAX Y = 3.0000 R0 RANGE Y = 8.3520 R0
 LINEAR LEAST-SQUARES CURVE FITTING PROGRAM
 MULTIPLE REGRESSION ANALYSIS FOR THE "ALPDS" MODEL

$$LNYA = 8(0) + 8(1)X1M + 8(2)X2M + 8(3)X3M + 8(4)X5 + 8(5)X6 + 8(6)X7$$

$$+ 8(7)X16 + 8(8)X14M + 8(9)X18M + 8(10)X20M + 8(11)X20S0$$

$$+ 8(12)X190S0 + 8(13)X140S0 + 8(14)X150S0 + 8(15)X170S0$$

$$+ 8(16)X180S0 + 8(17)X190S0 + 8(18)X20S0 + 8(19)X21DS0$$

$$+ 8(20)X18 + 8(21)X19$$

$$LNYA = LN(LSC/DM) LSC/DM (LOGISTICS SUPPORT COST PER OPERATING HOUR)$$

IND. VAR(I)	NAME	COEF. R(I)	S.E. COEF.	T-VALUE	R(I)SQRD	MIN X(I)	MAX X(I)	RANGE X(I)	REL. INF. X(I)
0									
1	X1M	-0.13180 R0	0.410-R1	0.8	0.9483	-2.0600-R1	7.1400-R1	1.0000 R0	0.46
2	X2M	3.06110 R0	0.530-R1	5.6	0.9484	-2.7000-R1	7.3000-R1	1.0000 R0	0.44
3	X3M	-0.06330 R0	2.500-R1	1.9	0.6022	-2.5400-R1	7.4000-R1	1.0000 R0	0.66
4	X5	-0.36660 R0	4.210-R1	0.1	0.3316	-2.1340-R1	5.3260-R1	7.4600-R1	0.23
5	X6	-1.06260 R0	4.760-R1	3.3	0.5433	-2.2710-R1	5.6900-R1	7.9400-R1	0.16
6	X7	-0.67250-R1	4.540-R1	1.6	0.5960	-2.1440-R1	5.7900-R1	7.9400-R1	0.07
7	X16	1.27350-R2	4.930-R3	2.6	0.4192	0.5300-R1	1.0000-R2	1.0000-R2	0.15
8	X14M	2.250670-R2	3.750-R3	6.0	0.7676	-6.3300-R1	3.6700-R1	1.0000-R2	0.27
9	X18M	-7.439900-R3	2.500-R3	3.0	0.6026	-6.1100-R1	3.6900-R1	1.0000-R2	0.00
10	X20M	2.38520 R0	4.500-R1	5.2	0.6327	-1.3400-R0	6.6800-R1	2.0000-R0	0.57
11	X20S0	-9.203840-R1	1.840-R1	5.0	0.4963	5.1950-R0	3.6250-R0	3.5700-R0	0.30
12	X190S0	-1.528640-R4	5.250-R5	2.9	0.5292	6.4640-R1	1.1970-R4	1.1970-R4	0.22
13	X140S0	-1.271800-R3	1.850-R4	5.8	0.8576	4.8800-R2	2.6210-R3	2.6210-R3	0.34
14	X150S0	1.204180-R3	2.000-R4	5.0	0.7188	6.4000-R1	2.8000-R3	2.7450-R3	0.48
15	X170S0	7.102250-R4	2.170-R4	3.3	0.8368	2.3100-R2	3.5760-R3	3.5450-R3	0.28
16	X180S0	-1.115600-R6	1.060-R4	1.5	0.4652	6.3720-R1	2.6800-R3	2.6050-R3	0.95
17	X190S0	5.85940 R0	4.200-R7	2.7	0.3924	2.2500-R2	0.4270-R5	6.4250-R5	0.11
18	X20S0	1.708420-R3	7.570-R1	6.5	0.8716	1.4590-R1	1.9100-R0	1.7640-R0	1.06
19	X21DS0	4.62930-R1	0.200-R2	5.6	0.4810	6.0230-R1	1.1360-R3	1.0700-R3	0.22
20	LNYA	2.353630-R1	1.060-R1	2.2	0.7320	3.4010-R0	9.8120-R0	7.6500-R0	0.42
21								5.6110-R0	0.16

NO. OF OBSERVATIONS 63
 NO. OF IND. VARIABLES 21
 RESIDUAL DEGREES OF FREEDOM 41
 F-VALUE 25.3
 RESIDUAL ROOT MEAN SQUARE 0.52289749
 RESIDUAL MEAN SQUARE 0.27342179
 RESIDUAL SUM OF SQUARES 11.21099323
 TOTAL SUM OF SQUARES 150.45132270
 MULT. CORREL. COEF. SQUARED .9283

REQUIRED X(I) PRECISION
 (DIGIT RIGHT OF DECIMAL POSITIVE,
 LEFT OF DECIMAL NEGATIVE)

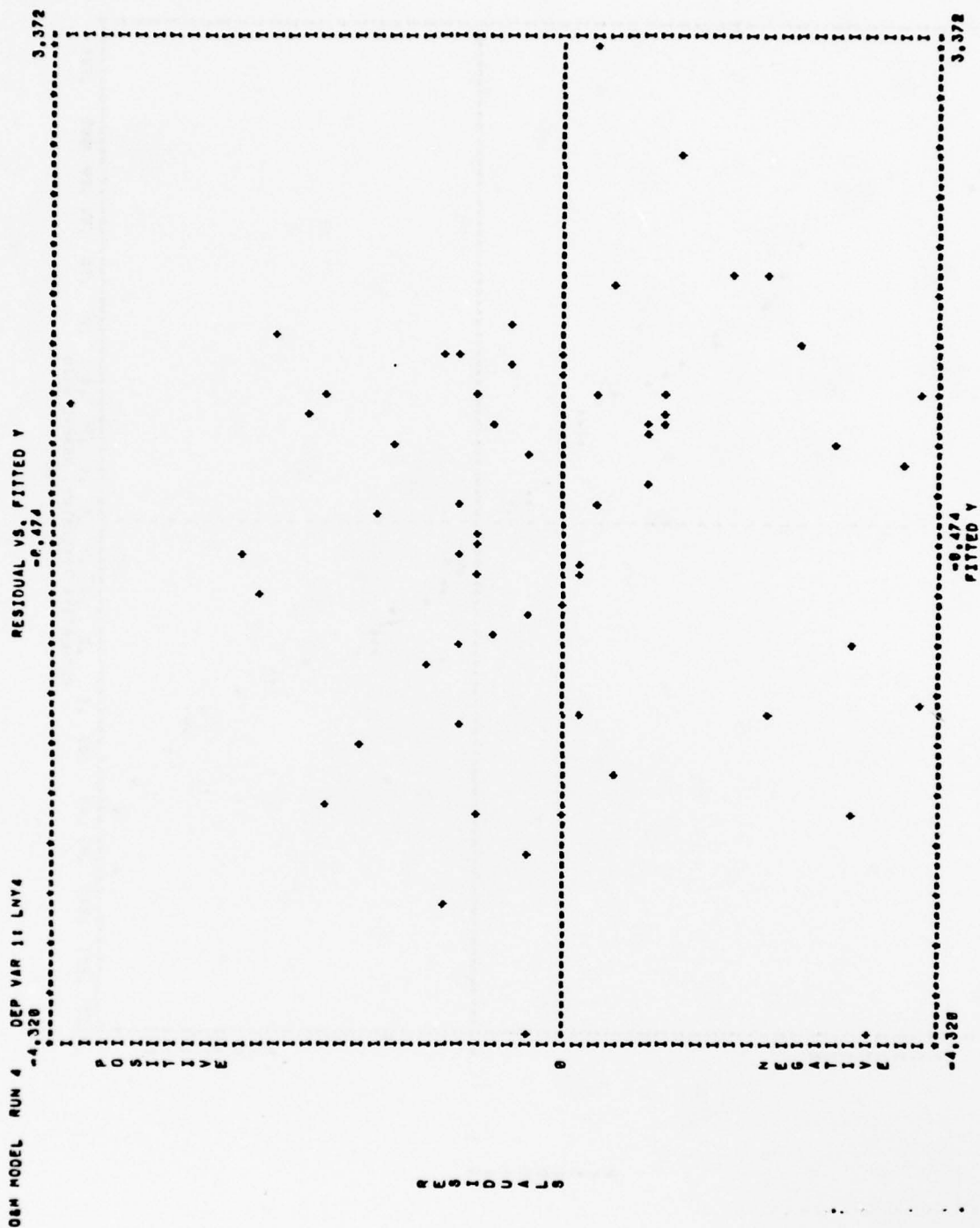
IND. VAR(I)	DIGIT
1	1
2	1
3	1
4	1
5	1
6	1
7	-2
8	-2
9	-2
10	-10
11	-4
12	-4
13	-3
14	-3
15	-3
16	-4
17	-6
18	-1
19	-3
20	1
21	1

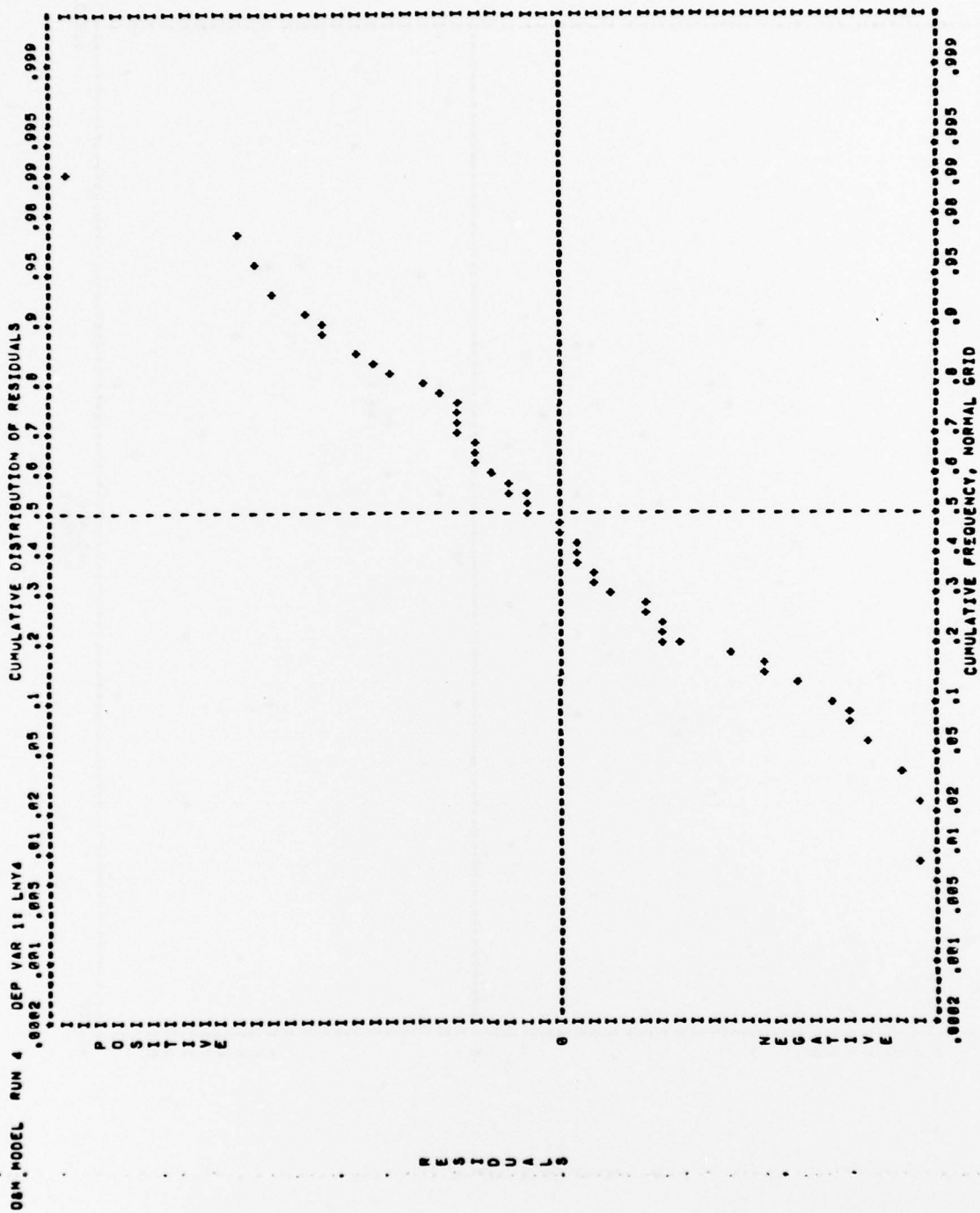
LINEAR LEAST-SQUARES CURVE FITTING PROGRAM									
OBS MODEL RUN 4 DEP VAR IS LNY4				RESIDUAL ROOT MEAN SQUARE OF FITTED EQUATION:				0.52	
STANDARD DEVIATION ESTIMATED FROM RESIDUALS OF NEIGHBORING OBSERVATIONS (OBSERVATIONS 1 TO 4 APART IN FITTED Y ORDER).									
NO.	CUMULATIVE		ORDERED BY WSSD		ORDERED BY WSSD		ORDERED BY WSSD		SEQ.
	STD DEV	WSSD	OBSV.	DEL RESIDUALS	WSSD	DEL RESIDUALS	WSSD	DEL RESIDUALS	
1	2.23	0.0	61	0.21	0.0	0.0	0.0	-4.32	1
2	2.33	0.0	57	0.56	0.42	1.03	0.42	-4.32	2
3	2.52	0.0	53	0.51	0.60	1.63	0.60	-3.19	3
4	2.75	0.0	67	0.65	1.30	121.45	0.13	-2.82	4
5	2.64	0.02	37	0.28	0.28	91.16	0.81	-2.55	5
6	2.58	0.17	58	0.56	0.26	5.66	0.69	-2.53	6
7	2.53	0.17	58	0.57	0.16	80.85	0.58	-2.53	7
8	2.55	1.52	7	0.8	0.99	80.59	0.69	-2.45	8
9	2.57	2.64	5	0.59	0.17	98.70	0.63	-2.22	9
10	2.57	2.22	57	0.3	0.65	115.56	0.25	-1.97	10
11	2.62	2.22	56	0.3	1.87	62.08	0.31	-1.68	11
12	2.68	2.27	48	0.44	0.37	88.68	0.44	-1.79	12
13	2.63	2.37	58	0.3	0.81	87.17	0.46	-1.78	13
14	2.65	2.44	27	0.67	0.89	136.93	0.83	-1.74	14
15	2.64	2.45	27	0.65	0.41	159.19	1.20	-1.70	15
16	2.64	2.51	37	0.67	0.69	116.02	0.11	-1.34	16
17	2.62	3.35	18	0.22	0.20	133.48	0.93	-1.20	17
18	2.59	3.37	6	1	0.12	143.03	0.83	-1.19	18
19	2.59	3.83	8	0.48	0.57	180.23	0.85	-1.16	19
20	2.59	4.57	1	0	0.24	68.76	0.69	-0.98	20
21	2.58	4.57	15	0.25	0.60	127.77	0.74	-0.98	21
22	2.59	5.06	8	12	0.60	80.53	0.54	-0.84	22
23	2.61	6.06	60	0.28	0.85	28.66	0.24	-0.72	23
24	2.59	6.06	12	12	0.12	128.53	0.82	-0.71	24
25	2.57	7.07	7	0.3	0.35	190.45	0.25	-0.60	25
26	2.57	7.07	26	0.53	0.29	32.68	0.25	-0.62	26
27	2.57	7.07	35	0.29	0.61	123.06	0.59	-0.54	27
28	2.56	8.11	31	0.31	0.35	23.83	0.58	-0.58	28
29	2.57	9.35	10	15	0.53	113.84	0.81	-0.43	29
30	2.56	9.35	59	13	0.26	180.87	0.25	-0.37	30
31	2.56	11.51	34	33	0.28	60.48	0.53	-0.22	31
32	2.56	11.72	52	58	0.63	47.61	0.33	-0.16	32
33	2.59	13.53	65	33	1.13	90.06	0.46	-0.11	33
34	2.57	13.55	67	33	0.17	7.94	0.61	0.03	34
35	2.55	16.68	34	31	0.67	190.19	0.91	0.13	35
36	2.54	19.31	10	9	0.69	180.42	0.33	0.23	36
37	2.53	20.60	1	18	0.24	25.24	1.05	0.20	37
38	2.53	21.19	64	35	0.41	126.35	0.43	0.30	38
39	2.54	23.12	21	25	1.83	116.16	0.82	0.42	39
40	2.57	23.56	4	58	1.27	44.80	0.38	0.44	40
41	2.57	23.51	43	44	0.75	127.78	0.33	0.47	41
42	2.56	23.71	6	18	0.12	146.14	0.84	0.47	42
43	2.57	23.77	2	13	0.70	6.08	0.85	0.51	43
44	2.57	23.83	58	62	0.58	190.21	0.55	0.53	44
45	2.59	24.23	4	56	1.81	25.50	1.27	0.61	45
46	2.68	24.23	4	67	1.43	6.17	0.19	0.66	46
47	2.62	25.24	50	2	1.85	6.0	0.42	0.66	47
48	2.63	25.24	30	68	1.88	185.77	0.37	0.68	48
49	2.64	25.55	13	4	1.88	184.35	1.43	0.68	49
50	2.63	25.90	48	43	0.36	329.27	0.69	0.71	50
51	2.63	27.09	12	43	0.26	359.68	0.69	0.82	51
52	2.62	27.59	15	21	0.37	6.02	0.28	0.89	52
53	2.61	30.72	41	5	0.28	190.19	0.29	0.90	53
54	2.61	32.08	9	46	0.25	0.0	0.21	1.02	54
55	2.61	32.66	65	34	0.85	113.84	0.62	1.02	55
56	2.61	33.61	67	34	0.45	9.68	1.38	1.02	56
57	2.68	35.43	1	46	0.82	157.56	0.57	1.02	57
58	2.68	35.86	68	32	0.68	107.79	0.28	1.12	58
59	2.59	37.12	38	68	0.89	11.51	0.28	1.22	59
60	2.59	37.48	53	28	0.15	116.01	0.68	1.52	60
61	2.59	37.46	51	28	0.05	3.35	0.28	1.52	61
62	2.68	40.46	59	48	0.64	118.39	0.55	1.62	62
63	2.59	41.63	52	62	0.25	180.05	0.25	1.62	63

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

IBM MODEL RUN 4 DEP VAR 11 LNY4

ORDERED BY COMPUTER INPUT				ORDERED BY RESIDUALS			
IDENT.	OBSV.	HSS DISTANCE	ORIG. Y	FITTED Y	RESIDUAL	OBSV.	FITTED Y
71527	1	24	-0.522	-0.720	-0.198	4	0.611
71528	2	44	-0.366	0.209	-0.508	54	0.265
71529	3	44	-0.174	0.611	-0.785	32	-0.041
71530	4	24	1.003	0.611	1.102	65	1.121
71531	5	24	-0.189	-0.113	0.222	28	0.531
71532	6	25	-0.988	-0.681	-1.086	36	-2.453
71533	7	31	-3.237	-3.189	-0.048	17	0.766
71534	8	26	-0.749	-0.729	-0.020	19	-1.972
71535	9	26	-0.659	-0.621	-0.038	41	0.223
71536	10	33	-0.749	-0.711	-0.038	59	0.085
71537	11	25	-2.547	-2.520	-0.027	21	-1.337
71538	12	35	0.597	0.467	0.130	27	0.085
71539	13	35	-1.782	-1.740	-0.042	7	-3.189
71540	14	45	1.253	0.786	0.467	43	-1.556
71541	15	45	1.191	1.028	0.163	38	-0.978
71542	16	55	-1.479	-1.972	0.493	5	-0.113
71543	17	66	-2.351	-2.349	-0.002	46	-0.326
71544	18	66	-1.018	-1.337	0.319	68	1.621
71545	19	53	-2.185	-2.592	0.407	28	-2.351
71546	20	45	-1.695	-1.192	-0.503	62	-0.322
71547	21	45	-0.287	0.330	-0.617	56	-0.427
71548	22	45	1.271	0.985	0.286	22	-0.370
71549	23	45	-0.970	-0.970	0.000	64	-1.031
71550	24	45	-0.970	-0.970	0.000	68	-0.597
71551	25	45	-0.970	-0.970	0.000	13	1.222
71552	26	45	-0.970	-0.970	0.000	27	0.080
71553	27	45	-0.970	-0.970	0.000	37	0.081
71554	28	45	-0.970	-0.970	0.000	28	0.081
71555	29	45	-0.970	-0.970	0.000	26	0.081
71556	30	45	-0.970	-0.970	0.000	20	0.081
71557	31	45	-0.970	-0.970	0.000	34	0.081
71558	32	45	-0.970	-0.970	0.000	30	0.081
71559	33	45	-0.970	-0.970	0.000	31	0.081
71560	34	45	-0.970	-0.970	0.000	32	0.081
71561	35	45	-0.970	-0.970	0.000	33	0.081
71562	36	45	-0.970	-0.970	0.000	35	0.081
71563	37	45	-0.970	-0.970	0.000	36	0.081
71564	38	45	-0.970	-0.970	0.000	37	0.081
71565	39	45	-0.970	-0.970	0.000	38	0.081
71566	40	45	-0.970	-0.970	0.000	39	0.081
71567	41	45	-0.970	-0.970	0.000	40	0.081
71568	42	45	-0.970	-0.970	0.000	41	0.081
71569	43	45	-0.970	-0.970	0.000	42	0.081
71570	44	45	-0.970	-0.970	0.000	43	0.081
71571	45	45	-0.970	-0.970	0.000	44	0.081
71572	46	45	-0.970	-0.970	0.000	45	0.081
71573	47	45	-0.970	-0.970	0.000	46	0.081
71574	48	45	-0.970	-0.970	0.000	47	0.081
71575	49	45	-0.970	-0.970	0.000	48	0.081
71576	50	45	-0.970	-0.970	0.000	49	0.081
71577	51	45	-0.970	-0.970	0.000	50	0.081
71578	52	45	-0.970	-0.970	0.000	51	0.081
71579	53	45	-0.970	-0.970	0.000	52	0.081
71580	54	45	-0.970	-0.970	0.000	53	0.081
71581	55	45	-0.970	-0.970	0.000	54	0.081
71582	56	45	-0.970	-0.970	0.000	55	0.081
71583	57	45	-0.970	-0.970	0.000	56	0.081
71584	58	45	-0.970	-0.970	0.000	57	0.081
71585	59	45	-0.970	-0.970	0.000	58	0.081
71586	60	45	-0.970	-0.970	0.000	59	0.081
71587	61	45	-0.970	-0.970	0.000	60	0.081
71588	62	45	-0.970	-0.970	0.000	61	0.081
71589	63	45	-0.970	-0.970	0.000	62	0.081
71590	64	45	-0.970	-0.970	0.000	63	0.081
71591	65	45	-0.970	-0.970	0.000	64	0.081
71592	66	45	-0.970	-0.970	0.000	65	0.081
71593	67	45	-0.970	-0.970	0.000	66	0.081
71594	68	45	-0.970	-0.970	0.000	67	0.081
71595	69	45	-0.970	-0.970	0.000	68	0.081
71596	70	45	-0.970	-0.970	0.000	69	0.081
71597	71	45	-0.970	-0.970	0.000	70	0.081
71598	72	45	-0.970	-0.970	0.000	71	0.081
71599	73	45	-0.970	-0.970	0.000	72	0.081
71600	74	45	-0.970	-0.970	0.000	73	0.081
71601	75	45	-0.970	-0.970	0.000	74	0.081
71602	76	45	-0.970	-0.970	0.000	75	0.081
71603	77	45	-0.970	-0.970	0.000	76	0.081
71604	78	45	-0.970	-0.970	0.000	77	0.081
71605	79	45	-0.970	-0.970	0.000	78	0.081
71606	80	45	-0.970	-0.970	0.000	79	0.081
71607	81	45	-0.970	-0.970	0.000	80	0.081
71608	82	45	-0.970	-0.970	0.000	81	0.081
71609	83	45	-0.970	-0.970	0.000	82	0.081
71610	84	45	-0.970	-0.970	0.000	83	0.081
71611	85	45	-0.970	-0.970	0.000	84	0.081
71612	86	45	-0.970	-0.970	0.000	85	0.081
71613	87	45	-0.970	-0.970	0.000	86	0.081
71614	88	45	-0.970	-0.970	0.000	87	0.081
71615	89	45	-0.970	-0.970	0.000	88	0.081
71616	90	45	-0.970	-0.970	0.000	89	0.081
71617	91	45	-0.970	-0.970	0.000	90	0.081
71618	92	45	-0.970	-0.970	0.000	91	0.081
71619	93	45	-0.970	-0.970	0.000	92	0.081
71620	94	45	-0.970	-0.970	0.000	93	0.081





LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

QAM MODEL RUN 5 DEP VAR 11 LMS MIN Y = -5.7930 BP MAX Y = 1.7970 BP RANGE Y = 7.5890 BP

MULTIPLE REGRESSION ANALYSIS FOR THE "ALPOS" MODEL

$$LMS = 8(0) + 8(1)X17 + 8(2)X37 + 8(3)X4M + 8(4)X5 + 8(5)X6 + 8(6)X13$$

$$+ 8(7)X17 + 8(8)X1M + 8(9)X14M + 8(10)X15M + 8(11)X16M$$

$$+ 8(12)X10S0 + 8(13)X110S0 + 8(14)X140S0 + 8(15)X150S0$$

$$+ 8(16)X160S0 + 8(17)X180S0 + 8(18)X190S0 + 8(19)X200S0$$

$$+ 8(20)X210S0 + 8(21)X26$$

$$LMS = LN(TRAIN/ON) TRAIN/ON (TRAINING COST PER OPERATING HOUR)$$

IND. VAR (I)	NAME	COEF. B(I)	S.E. COEF.	T-VALUE	R(1)SQRD	MIN X(I)	MAX X(I)	RANGE X(I)	REL. INF. X(I)
0		3.174600 BP							
1	X1M	7.479470 BP	2.890 BP	2.5	0.5861	-2.8890 BP	7.1890 BP	1.0890 BP	0.18
2	X3M	-7.172710 BP	3.350 BP	2.1	0.5781	-2.8890 BP	7.4280 BP	1.0890 BP	0.18
3	X4M	-1.376410 BP	3.390 BP	4.8	0.4942	-1.8480 BP	0.4940 BP	1.0890 BP	0.18
4	X5	-2.249490 BP	3.820 BP	3.8	0.3838	-2.1520 BP	5.2680 BP	7.4280 BP	0.22
5	X6	-1.382970 BP	6.170 BP	2.2	0.3834	-2.3370 BP	5.7230 BP	8.0600 BP	0.15
6	X13	-2.255940 BP	6.740 BP	2.6	0.9977	0.8	1.8480 BP	1.8480 BP	2.877
7	X17	-2.843140 BP	6.750 BP	2.3	0.9969	0.8	1.8480 BP	1.8480 BP	2.877
8	X11M	2.388160 BP	1.240 BP	1.9	0.6114	-8.8420 BP	6.7480 BP	7.5900 BP	2.59
9	X14M	-2.894370 BP	8.560 BP	2.4	0.9991	-4.2580 BP	3.7580 BP	1.0890 BP	2.74
10	X15M	-2.874420 BP	8.690 BP	2.4	0.9988	-1.8480 BP	0.4940 BP	1.0890 BP	2.74
11	X16M	-2.188390 BP	6.640 BP	2.5	0.9961	-3.4800 BP	9.6520 BP	1.0890 BP	2.68
12	X10S0	-3.894990 BP	6.710 BP	4.6	0.3852	1.2540 BP	1.920 BP	1.1920 BP	0.49
13	X110S0	-1.614110 BP	4.320 BP	3.7	0.5195	4.8800 BP	2.1070 BP	2.1070 BP	0.46
14	X140S0	-4.981710 BP	1.890 BP	2.6	0.7198	4.8800 BP	2.5810 BP	2.5810 BP	0.17
15	X150S0	4.946610 BP	2.320 BP	2.1	0.5398	5.6230 BP	2.8620 BP	2.8620 BP	0.18
16	X160S0	-1.428490 BP	8.770 BP	1.6	0.3811	1.7480 BP	7.7650 BP	7.7650 BP	0.15
17	X180S0	-4.954750 BP	1.460 BP	3.4	0.3968	6.1360 BP	2.6210 BP	2.6210 BP	0.17
18	X190S0	-1.398320 BP	6.210 BP	2.3	0.4119	2.8980 BP	8.3910 BP	8.3910 BP	0.15
19	X200S0	1.512220 BP	6.420 BP	2.4	0.6216	1.4730 BP	1.9150 BP	1.7680 BP	0.35
20	X210S0	1.939330 BP	6.580 BP	2.9	0.4485	6.3840 BP	1.1680 BP	1.8970 BP	0.28
21	LMS	3.649860 BP	8.820 BP	4.1	0.3257	5.6380 BP	1.2890 BP	7.6560 BP	0.37

NO. OF OBSERVATIONS 82
 NO. OF IND. VARIABLES 21
 RESIDUAL DEGREES OF FREEDOM 48
 F-VALUE 11.7
 RESIDUAL ROOT MEAN SQUARE 0.75829222
 RESIDUAL MEAN SQUARE 0.56293842
 RESIDUAL SUM OF SQUARES 22.51753698
 TOTAL SUM OF SQUARES 188.76786788
 MULT. CORREL. COEF. SQUARED .8599

REQUIRED X(I) PRECISION
 (DIGIT RIGHT OF DECIMAL POSITIVE,
 LEFT OF DECIMAL NEGATIVE)

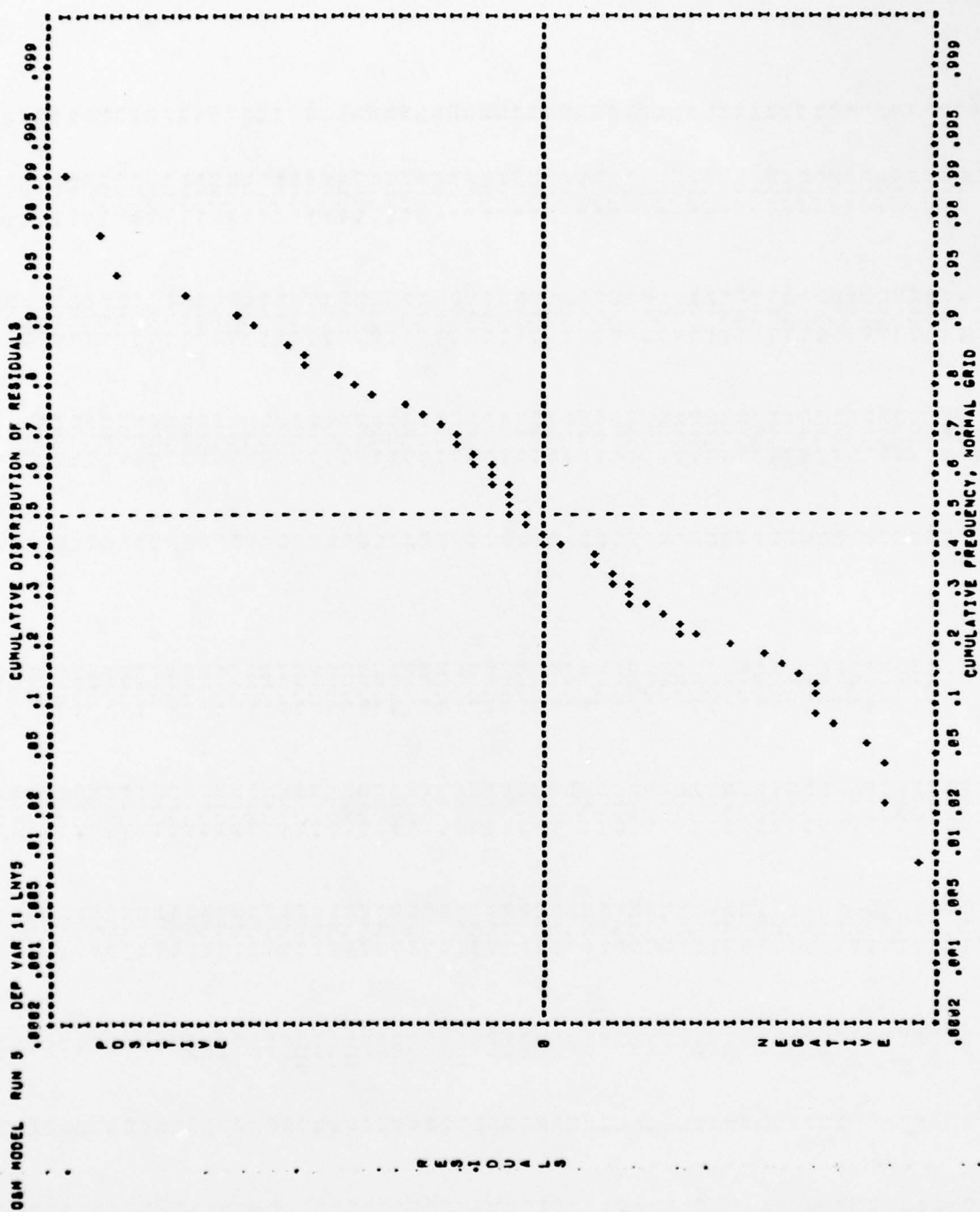
IND. VAR (I)	DIGIT
1	1
2	1
3	1
4	1
5	1
6	1
7	1
8	-4
9	1
10	1
11	1
12	-4
13	-4
14	-4
15	-3
16	-3
17	-4
18	-6
19	1
20	1
21	1

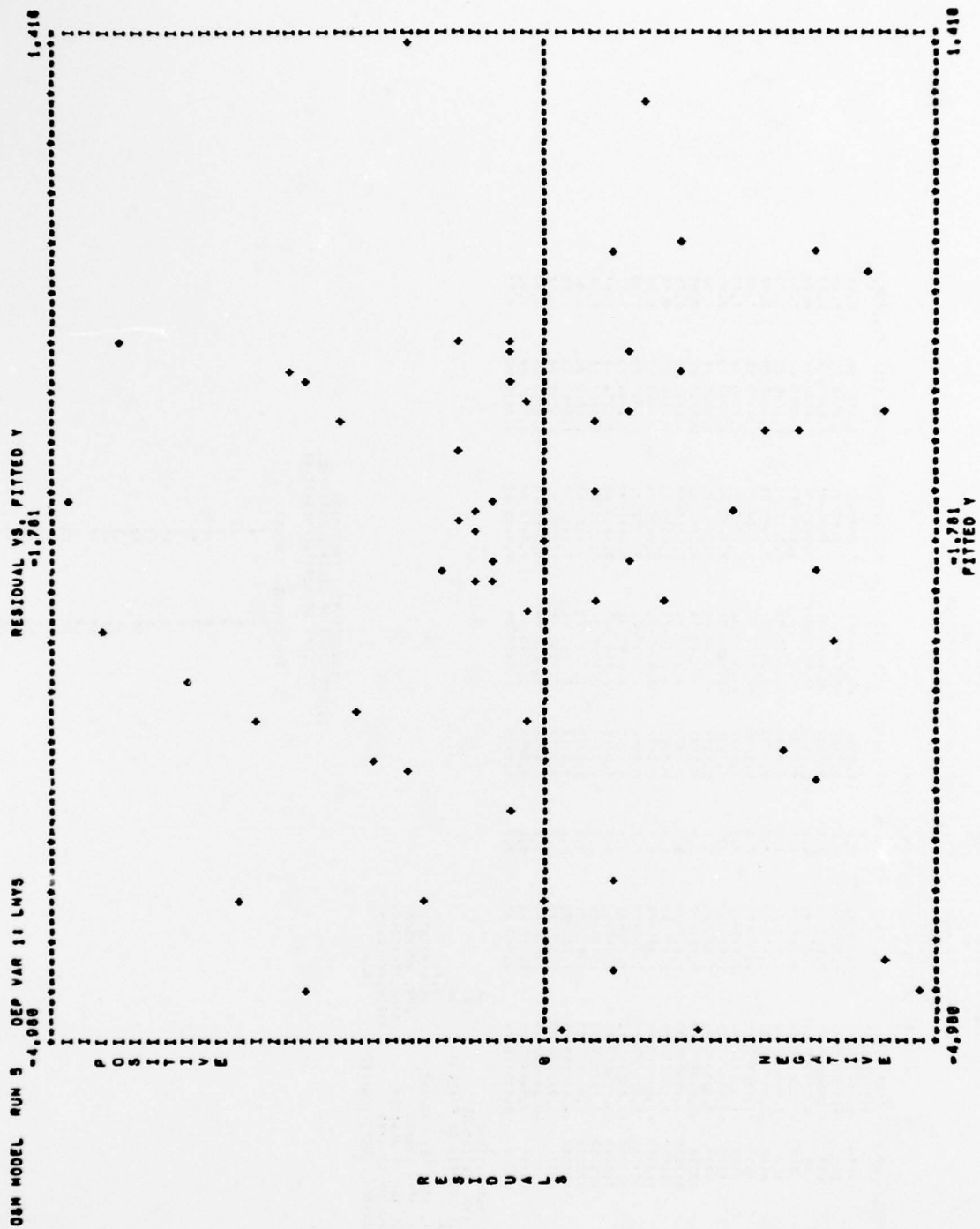
LINEAR LEAST-SQUARES CURVE FITTING PROGRAM									
OAM MODEL RUN 5			DEP VAR 11 LNVS			RESIDUAL ROOT MEAN SQUARE OF FITTED EQUATION			0.75
STANDARD DEVIATION ESTIMATED FROM RESIDUALS OF NEIGHBORING OBSERVATIONS (OBSERVATIONS 1 TO 4 APART IN FITTED Y ORDER).									
NO.	CUMULATIVE		ORDERED BY #SSD		ORDERED BY #SSD		ORDERED BY FITTED Y		SEQ.
	STD DEV	SSD	DEV	SSD	DEL	DEL	DEL	OBSV.	
1	0.17	0.0	61	0.15	0.0	0.48	-4.98	53	1
2	0.42	0.0	57	0.60	1542.14	0.77	-4.98	51	2
3	0.43	0.0	53	0.40	0.36	1.09	-4.03	7	3
4	0.50	0.01	37	0.64	2.99	0.95	-4.62	36	4
5	0.58	0.17	56	0.83	6.62	0.81	-4.53	28	5
6	0.60	0.28	29	1.11	7.78	1.03	-4.40	12	6
7	0.60	0.36	36	1.69	22.13	0.08	-4.08	19	7
8	0.91	1.16	56	0.97	13.99	0.72	-3.86	54	8
9	0.93	1.31	27	1.17	3.25	0.57	-3.84	48	9
10	0.92	1.39	37	0.53	1632.48	0.36	-3.94	8	10
11	0.85	1.78	36	0.14	1356.23	0.95	-3.50	46	11
12	0.79	2.25	18	0.12	1284.26	1.23	-3.31	39	12
13	0.74	2.72	7	0.10	1621.74	0.11	-3.20	38	13
14	0.76	2.83	7	0.94	1143.73	1.25	-3.10	43	14
15	0.84	2.60	7	1.75	424.00	1.61	-3.12	18	15
16	0.85	2.90	36	0.95	11.69	0.84	-2.93	44	16
17	0.80	3.14	3	0.61	456.47	0.56	-2.89	15	17
18	0.85	3.15	3	0.60	558.07	0.52	-2.80	08	18
19	0.82	3.23	36	2.06	780.76	1.08	-2.64	11	19
20	0.91	3.25	48	0.97	4.10	2.21	-2.41	23	20
21	0.84	3.33	29	1.42	20.32	1.26	-2.35	32	21
22	0.82	3.63	67	0.52	1481.74	0.45	-2.23	9	22
23	0.94	3.63	67	0.37	1624.03	0.22	-2.17	48	23
24	0.88	3.63	64	0.29	1532.64	0.33	-2.15	21	24
25	0.88	3.63	12	1.30	885.25	0.44	-2.02	47	25
26	0.80	3.97	12	0.70	8.46	1.03	-2.00	13	26
27	0.80	4.10	25	2.21	164.15	1.13	-1.98	59	27
28	0.95	4.40	67	0.74	1547.73	0.15	-1.97	52	28
29	0.94	4.44	19	0.97	1512.00	0.41	-1.91	55	29
30	0.94	4.58	57	0.67	1265.88	0.25	-1.80	35	30
31	0.91	4.58	55	0.66	1928.60	0.23	-1.74	34	31
32	0.88	4.83	57	0.58	22.87	0.81	-1.60	34	32
33	0.91	4.83	56	1.10	75.63	0.63	-1.65	34	33
34	0.96	4.83	37	0.58	0.17	0.93	-1.60	58	34
35	0.87	4.69	37	0.63	5.79	1.25	-1.57	66	35
36	0.87	4.69	28	0.54	21.38	1.32	-1.53	28	36
37	0.85	4.74	26	0.38	3.63	0.28	-1.51	64	37
38	0.88	4.91	44	1.74	78.75	0.48	-1.43	62	38
39	0.89	5.10	27	0.63	9.28	1.06	-1.40	28	39
40	0.97	5.21	5	0.14	1550.00	0.12	-1.36	29	40
41	0.80	5.22	19	1.14	1553.68	0.49	-1.07	40	41
42	0.87	5.30	52	0.57	6.31	0.48	-1.03	42	42
43	0.88	5.70	66	1.25	36.35	1.04	-0.97	17	43
44	0.82	5.93	58	2.88	1334.26	0.77	-0.95	17	44
45	0.82	6.02	20	0.61	1141.78	0.36	-0.92	42	45
46	0.82	6.74	61	1.11	379.03	0.88	-0.85	24	46
47	0.93	6.74	60	1.26	4.65	0.83	-0.78	37	47
48	0.92	7.55	5	0.50	9.0	0.68	-0.74	57	48
49	0.95	7.70	12	1.93	4.58	0.68	-0.74	56	49
50	0.94	7.97	26	0.45	1.31	1.17	-0.69	27	50
51	0.93	8.61	61	0.38	1385.01	0.35	-0.67	5	51
52	0.92	8.61	68	0.45	1483.27	0.30	-0.58	45	52
53	0.92	8.91	63	0.68	606.66	1.06	-0.55	67	53
54	0.92	8.94	15	0.98	899.88	1.19	-0.47	54	54
55	0.92	8.46	13	1.63	8.9	0.15	-0.47	61	55
56	0.93	9.24	26	1.86	6.74	1.26	-0.47	68	56
57	0.94	9.58	15	1.38	3.14	0.81	-0.40	57	57
58	0.93	9.66	29	0.62	184.46	0.68	-0.37	18	58
59	0.92	10.70	54	0.25	467.09	0.43	-0.36	41	59
60	0.92	11.00	44	0.84	426.09	0.18	-0.17	23	60
61	0.91	13.99	54	0.32	139.83	0.71	-1.03	61	61
62	0.91	15.65	58	0.76	1542.14	1.10	-1.42	31	62

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

QEM MODEL RUN 5 DEP VAR 11 LNY5

ORDERED BY COMPUTER INPUT			ORDERED BY RESIDUALS		
IDENT.	OBSV.	WSS DISTANCE	OBSV.	FITTED Y	ORDERED RESID.
71828	1	-1.427	28	-0.865	1.466
71829	2	-1.427	29	-1.331	1.466
71830	3	-1.427	30	-0.778	1.466
71831	4	-1.427	31	-1.331	1.466
71832	5	-1.427	32	-0.778	1.466
71833	6	-1.427	33	-1.331	1.466
71834	7	-1.427	34	-0.778	1.466
71835	8	-1.427	35	-1.331	1.466
71836	9	-1.427	36	-0.778	1.466
71837	10	-1.427	37	-1.331	1.466
71838	11	-1.427	38	-0.778	1.466
71839	12	-1.427	39	-1.331	1.466
71840	13	-1.427	40	-0.778	1.466
71841	14	-1.427	41	-1.331	1.466
71842	15	-1.427	42	-0.778	1.466
71843	16	-1.427	43	-1.331	1.466
71844	17	-1.427	44	-0.778	1.466
71845	18	-1.427	45	-1.331	1.466
71846	19	-1.427	46	-0.778	1.466
71847	20	-1.427	47	-1.331	1.466
71848	21	-1.427	48	-0.778	1.466
71849	22	-1.427	49	-1.331	1.466
71850	23	-1.427	50	-0.778	1.466
71851	24	-1.427	51	-1.331	1.466
71852	25	-1.427	52	-0.778	1.466
71853	26	-1.427	53	-1.331	1.466
71854	27	-1.427	54	-0.778	1.466
71855	28	-1.427	55	-1.331	1.466
71856	29	-1.427	56	-0.778	1.466
71857	30	-1.427	57	-1.331	1.466
71858	31	-1.427	58	-0.778	1.466
71859	32	-1.427	59	-1.331	1.466
71860	33	-1.427	60	-0.778	1.466
71861	34	-1.427	61	-1.331	1.466
71862	35	-1.427	62	-0.778	1.466
71863	36	-1.427	63	-1.331	1.466
71864	37	-1.427	64	-0.778	1.466
71865	38	-1.427	65	-1.331	1.466
71866	39	-1.427	66	-0.778	1.466
71867	40	-1.427	67	-1.331	1.466
71868	41	-1.427	68	-0.778	1.466
71869	42	-1.427	69	-1.331	1.466
71870	43	-1.427	70	-0.778	1.466
71871	44	-1.427	71	-1.331	1.466
71872	45	-1.427	72	-0.778	1.466
71873	46	-1.427	73	-1.331	1.466
71874	47	-1.427	74	-0.778	1.466
71875	48	-1.427	75	-1.331	1.466
71876	49	-1.427	76	-0.778	1.466
71877	50	-1.427	77	-1.331	1.466
71878	51	-1.427	78	-0.778	1.466
71879	52	-1.427	79	-1.331	1.466
71880	53	-1.427	80	-0.778	1.466
71881	54	-1.427	81	-1.331	1.466
71882	55	-1.427	82	-0.778	1.466
71883	56	-1.427	83	-1.331	1.466
71884	57	-1.427	84	-0.778	1.466
71885	58	-1.427	85	-1.331	1.466
71886	59	-1.427	86	-0.778	1.466
71887	60	-1.427	87	-1.331	1.466
71888	61	-1.427	88	-0.778	1.466
71889	62	-1.427	89	-1.331	1.466
71890	63	-1.427	90	-0.778	1.466
71891	64	-1.427	91	-1.331	1.466
71892	65	-1.427	92	-0.778	1.466
71893	66	-1.427	93	-1.331	1.466
71894	67	-1.427	94	-0.778	1.466
71895	68	-1.427	95	-1.331	1.466
71896	69	-1.427	96	-0.778	1.466
71897	70	-1.427	97	-1.331	1.466
71898	71	-1.427	98	-0.778	1.466
71899	72	-1.427	99	-1.331	1.466
71900	73	-1.427	100	-0.778	1.466





LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

QAM MODEL RUN 6 DEP VAR 11 Y6 MIN Y = 0.0 MAX Y = 1.0000 E2 RANGE Y = 1.0000 E2

MULTIPLE REGRESSION ANALYSIS FOR THE "ALPOS" MODEL

Y6 = B(0) + B(1)X1M + B(2)X2M + B(3)X3M + B(4)X4 + B(5)X16 + B(6)X9M
 + B(7)X12M + B(8)X13M + B(9)X14M + B(10)X17M + B(11)X22PM
 + B(12)X030 + B(13)X11030 + B(14)X12030 + B(15)X13030
 + B(16)X14030 + B(17)X15030 + B(18)X17030 + B(19)X19030
 + B(20)X2030 + B(21)X21030 + B(22)X1M0 + B(23)X1M0
 + B(24)X11 + B(25)X12 + B(26)X13 + B(27)X14 + B(28)X15 + B(29)X16 + B(30)X17 + B(31)X18 + B(32)X19 + B(33)X20 + B(34)X21 + B(35)X22 + B(36)X23 + B(37)X24 + B(38)X25 + B(39)X26 + B(40)X27 + B(41)X28 + B(42)X29 + B(43)X30 + B(44)X31 + B(45)X32 + B(46)X33 + B(47)X34 + B(48)X35 + B(49)X36 + B(50)X37 + B(51)X38 + B(52)X39 + B(53)X40 + B(54)X41 + B(55)X42 + B(56)X43 + B(57)X44 + B(58)X45 + B(59)X46 + B(60)X47 + B(61)X48 + B(62)X49 + B(63)X50 + B(64)X51 + B(65)X52 + B(66)X53 + B(67)X54 + B(68)X55 + B(69)X56 + B(70)X57 + B(71)X58 + B(72)X59 + B(73)X60 + B(74)X61 + B(75)X62 + B(76)X63 + B(77)X64 + B(78)X65 + B(79)X66 + B(80)X67 + B(81)X68 + B(82)X69 + B(83)X70 + B(84)X71 + B(85)X72 + B(86)X73 + B(87)X74 + B(88)X75 + B(89)X76 + B(90)X77 + B(91)X78 + B(92)X79 + B(93)X80 + B(94)X81 + B(95)X82 + B(96)X83 + B(97)X84 + B(98)X85 + B(99)X86 + B(100)X87 + B(101)X88 + B(102)X89 + B(103)X90 + B(104)X91 + B(105)X92 + B(106)X93 + B(107)X94 + B(108)X95 + B(109)X96 + B(110)X97 + B(111)X98 + B(112)X99 + B(113)X100 + B(114)X101 + B(115)X102 + B(116)X103 + B(117)X104 + B(118)X105 + B(119)X106 + B(120)X107 + B(121)X108 + B(122)X109 + B(123)X110 + B(124)X111 + B(125)X112 + B(126)X113 + B(127)X114 + B(128)X115 + B(129)X116 + B(130)X117 + B(131)X118 + B(132)X119 + B(133)X120 + B(134)X121 + B(135)X122 + B(136)X123 + B(137)X124 + B(138)X125 + B(139)X126 + B(140)X127 + B(141)X128 + B(142)X129 + B(143)X130 + B(144)X131 + B(145)X132 + B(146)X133 + B(147)X134 + B(148)X135 + B(149)X136 + B(150)X137 + B(151)X138 + B(152)X139 + B(153)X140 + B(154)X141 + B(155)X142 + B(156)X143 + B(157)X144 + B(158)X145 + B(159)X146 + B(160)X147 + B(161)X148 + B(162)X149 + B(163)X150 + B(164)X151 + B(165)X152 + B(166)X153 + B(167)X154 + B(168)X155 + B(169)X156 + B(170)X157 + B(171)X158 + B(172)X159 + B(173)X160 + B(174)X161 + B(175)X162 + B(176)X163 + B(177)X164 + B(178)X165 + B(179)X166 + B(180)X167 + B(181)X168 + B(182)X169 + B(183)X170 + B(184)X171 + B(185)X172 + B(186)X173 + B(187)X174 + B(188)X175 + B(189)X176 + B(190)X177 + B(191)X178 + B(192)X179 + B(193)X180 + B(194)X181 + B(195)X182 + B(196)X183 + B(197)X184 + B(198)X185 + B(199)X186 + B(200)X187 + B(201)X188 + B(202)X189 + B(203)X190 + B(204)X191 + B(205)X192 + B(206)X193 + B(207)X194 + B(208)X195 + B(209)X196 + B(210)X197 + B(211)X198 + B(212)X199 + B(213)X200 + B(214)X201 + B(215)X202 + B(216)X203 + B(217)X204 + B(218)X205 + B(219)X206 + B(220)X207 + B(221)X208 + B(222)X209 + B(223)X210 + B(224)X211 + B(225)X212 + B(226)X213 + B(227)X214 + B(228)X215 + B(229)X216 + B(230)X217 + B(231)X218 + B(232)X219 + B(233)X220 + B(234)X221 + B(235)X222 + B(236)X223 + B(237)X224 + B(238)X225 + B(239)X226 + B(240)X227 + B(241)X228 + B(242)X229 + B(243)X230 + B(244)X231 + B(245)X232 + B(246)X233 + B(247)X234 + B(248)X235 + B(249)X236 + B(250)X237 + B(251)X238 + B(252)X239 + B(253)X240 + B(254)X241 + B(255)X242 + B(256)X243 + B(257)X244 + B(258)X245 + B(259)X246 + B(260)X247 + B(261)X248 + B(262)X249 + B(263)X250 + B(264)X251 + B(265)X252 + B(266)X253 + B(267)X254 + B(268)X255 + B(269)X256 + B(270)X257 + B(271)X258 + B(272)X259 + B(273)X260 + B(274)X261 + B(275)X262 + B(276)X263 + B(277)X264 + B(278)X265 + B(279)X266 + B(280)X267 + B(281)X268 + B(282)X269 + B(283)X270 + B(284)X271 + B(285)X272 + B(286)X273 + B(287)X274 + B(288)X275 + B(289)X276 + B(290)X277 + B(291)X278 + B(292)X279 + B(293)X280 + B(294)X281 + B(295)X282 + B(296)X283 + B(297)X284 + B(298)X285 + B(299)X286 + B(300)X287 + B(301)X288 + B(302)X289 + B(303)X290 + B(304)X291 + B(305)X292 + B(306)X293 + B(307)X294 + B(308)X295 + B(309)X296 + B(310)X297 + B(311)X298 + B(312)X299 + B(313)X300 + B(314)X301 + B(315)X302 + B(316)X303 + B(317)X304 + B(318)X305 + B(319)X306 + B(320)X307 + B(321)X308 + B(322)X309 + B(323)X310 + B(324)X311 + B(325)X312 + B(326)X313 + B(327)X314 + B(328)X315 + B(329)X316 + B(330)X317 + B(331)X318 + B(332)X319 + B(333)X320 + B(334)X321 + B(335)X322 + B(336)X323 + B(337)X324 + B(338)X325 + B(339)X326 + B(340)X327 + B(341)X328 + B(342)X329 + B(343)X330 + B(344)X331 + B(345)X332 + B(346)X333 + B(347)X334 + B(348)X335 + B(349)X336 + B(350)X337 + B(351)X338 + B(352)X339 + B(353)X340 + B(354)X341 + B(355)X342 + B(356)X343 + B(357)X344 + B(358)X345 + B(359)X346 + B(360)X347 + B(361)X348 + B(362)X349 + B(363)X350 + B(364)X351 + B(365)X352 + B(366)X353 + B(367)X354 + B(368)X355 + B(369)X356 + B(370)X357 + B(371)X358 + B(372)X359 + B(373)X360 + B(374)X361 + B(375)X362 + B(376)X363 + B(377)X364 + B(378)X365 + B(379)X366 + B(380)X367 + B(381)X368 + B(382)X369 + B(383)X370 + B(384)X371 + B(385)X372 + B(386)X373 + B(387)X374 + B(388)X375 + B(389)X376 + B(390)X377 + B(391)X378 + B(392)X379 + B(393)X380 + B(394)X381 + B(395)X382 + B(396)X383 + B(397)X384 + B(398)X385 + B(399)X386 + B(400)X387 + B(401)X388 + B(402)X389 + B(403)X390 + B(404)X391 + B(405)X392 + B(406)X393 + B(407)X394 + B(408)X395 + B(409)X396 + B(410)X397 + B(411)X398 + B(412)X399 + B(413)X400 + B(414)X401 + B(415)X402 + B(416)X403 + B(417)X404 + B(418)X405 + B(419)X406 + B(420)X407 + B(421)X408 + B(422)X409 + B(423)X410 + B(424)X411 + B(425)X412 + B(426)X413 + B(427)X414 + B(428)X415 + B(429)X416 + B(430)X417 + B(431)X418 + B(432)X419 + B(433)X420 + B(434)X421 + B(435)X422 + B(436)X423 + B(437)X424 + B(438)X425 + B(439)X426 + B(440)X427 + B(441)X428 + B(442)X429 + B(443)X430 + B(444)X431 + B(445)X432 + B(446)X433 + B(447)X434 + B(448)X435 + B(449)X436 + B(450)X437 + B(451)X438 + B(452)X439 + B(453)X440 + B(454)X441 + B(455)X442 + B(456)X443 + B(457)X444 + B(458)X445 + B(459)X446 + B(460)X447 + B(461)X448 + B(462)X449 + B(463)X450 + B(464)X451 + B(465)X452 + B(466)X453 + B(467)X454 + B(468)X455 + B(469)X456 + B(470)X457 + B(471)X458 + B(472)X459 + B(473)X460 + B(474)X461 + B(475)X462 + B(476)X463 + B(477)X464 + B(478)X465 + B(479)X466 + B(480)X467 + B(481)X468 + B(482)X469 + B(483)X470 + B(484)X471 + B(485)X472 + B(486)X473 + B(487)X474 + B(488)X475 + B(489)X476 + B(490)X477 + B(491)X478 + B(492)X479 + B(493)X480 + B(494)X481 + B(495)X482 + B(496)X483 + B(497)X484 + 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B(575)X562 + B(576)X563 + B(577)X564 + B(578)X565 + B(579)X566 + B(580)X567 + B(581)X568 + B(582)X569 + B(583)X570 + B(584)X571 + B(585)X572 + B(586)X573 + B(587)X574 + B(588)X575 + B(589)X576 + B(590)X577 + B(591)X578 + B(592)X579 + B(593)X580 + B(594)X581 + B(595)X582 + B(596)X583 + B(597)X584 + B(598)X585 + B(599)X586 + B(600)X587 + B(601)X588 + B(602)X589 + B(603)X590 + B(604)X591 + B(605)X592 + B(606)X593 + B(607)X594 + B(608)X595 + B(609)X596 + B(610)X597 + B(611)X598 + B(612)X599 + B(613)X600 + B(614)X601 + B(615)X602 + B(616)X603 + B(617)X604 + B(618)X605 + B(619)X606 + B(620)X607 + B(621)X608 + B(622)X609 + B(623)X610 + B(624)X611 + B(625)X612 + B(626)X613 + B(627)X614 + B(628)X615 + B(629)X616 + B(630)X617 + B(631)X618 + B(632)X619 + B(633)X620 + B(634)X621 + B(635)X622 + B(636)X623 + B(637)X624 + B(638)X625 + B(639)X626 + B(640)X627 + B(641)X628 + B(642)X629 + B(643)X630 + B(644)X631 + B(645)X632 + B(646)X633 + B(647)X634 + B(648)X635 + B(649)X636 + B(650)X637 + B(651)X638 + B(652)X639 + B(653)X640 + B(654)X641 + B(655)X642 + B(656)X643 + B(657)X644 + B(658)X645 + B(659)X646 + B(660)X647 + B(661)X648 + B(662)X649 + B(663)X650 + B(664)X651 + B(665)X652 + B(666)X653 + B(667)X654 + B(668)X655 + B(669)X656 + B(670)X657 + B(671)X658 + B(672)X659 + B(673)X660 + B(674)X661 + B(675)X662 + B(676)X663 + B(677)X664 + B(678)X665 + B(679)X666 + B(680)X667 + B(681)X668 + B(682)X669 + B(683)X670 + B(684)X671 + B(685)X672 + B(686)X673 + B(687)X674 + B(688)X675 + B(689)X676 + B(690)X677 + B(691)X678 + B(692)X679 + B(693)X680 + B(694)X681 + B(695)X682 + B(696)X683 + B(697)X684 + B(698)X685 + B(699)X686 + B(700)X687 + B(701)X688 + B(702)X689 + B(703)X690 + B(704)X691 + B(705)X692 + B(706)X693 + B(707)X694 + B(708)X695 + B(709)X696 + B(710)X697 + B(711)X698 + B(712)X699 + B(713)X700 + B(714)X701 + B(715)X702 + B(716)X703 + B(717)X704 + B(718)X705 + B(719)X706 + B(720)X707 + B(721)X708 + B(722)X709 + B(723)X710 + B(724)X711 + B(725)X712 + B(726)X713 + B(727)X714 + B(728)X715 + B(729)X716 + B(730)X717 + B(731)X718 + B(732)X719 + B(733)X720 + B(734)X721 + B(735)X722 + B(736)X723 + B(737)X724 + B(738)X725 + B(739)X726 + B(740)X727 + B(741)X728 + B(742)X729 + B(743)X730 + B(744)X731 + B(745)X732 + B(746)X733 + B(747)X734 + B(748)X735 + B(749)X736 + B(750)X737 + B(751)X738 + B(752)X739 + B(753)X740 + B(754)X741 + B(755)X742 + B(756)X743 + B(757)X744 + B(758)X745 + B(759)X746 + B(760)X747 + B(761)X748 + B(762)X749 + B(763)X750 + B(764)X751 + B(765)X752 + B(766)X753 + B(767)X754 + B(768)X755 + B(769)X756 + B(770)X757 + B(771)X758 + B(772)X759 + B(773)X760 + B(774)X761 + B(775)X762 + B(776)X763 + B(777)X764 + B(778)X765 + B(779)X766 + B(780)X767 + B(781)X768 + B(782)X769 + B(783)X770 + B(784)X771 + B(785)X772 + B(786)X773 + B(787)X774 + B(788)X775 + B(789)X776 + B(790)X777 + B(791)X778 + B(792)X779 + B(793)X780 + B(794)X781 + B(795)X782 + B(796)X783 + B(797)X784 + B(798)X785 + B(799)X786 + B(800)X787 + B(801)X788 + B(802)X789 + B(803)X790 + B(804)X791 + B(805)X792 + B(806)X793 + B(807)X794 + B(808)X795 + B(809)X796 + B(810)X797 + B(811)X798 + B(812)X799 + B(813)X800 + B(814)X801 + B(815)X802 + B(816)X803 + B(817)X804 + B(818)X805 + B(819)X806 + B(820)X807 + B(821)X808 + B(822)X809 + B(823)X810 + B(824)X811 + B(825)X812 + B(826)X813 + B(827)X814 + B(828)X815 + B(829)X816 + B(830)X817 + B(831)X818 + B(832)X819 + B(833)X820 + B(834)X821 + B(835)X822 + B(836)X823 + B(837)X824 + B(838)X825 + B(839)X826 + B(840)X827 + B(841)X828 + B(842)X829 + B(843)X830 + B(844)X831 + B(845)X832 + B(846)X833 + B(847)X834 + B(848)X835 + B(849)X836 + B(850)X837 + B(851)X838 + B(852)X839 + B(853)X840 + B(854)X841 + B(855)X842 + B(856)X843 + B(857)X844 + B(858)X845 + B(859)X846 + B(860)X847 + B(861)X848 + B(862)X849 + B(863)X850 + B(864)X851 + B(865)X852 + B(866)X853 + B(867)X854 + B(868)X855 + B(869)X856 + B(870)X857 + B(871)X858 + B(872)X859 + B(873)X860 + B(874)X861 + B(875)X862 + B(876)X863 + B(877)X864 + B(878)X865 + B(879)X866 + B(880)X867 + B(881)X868 + B(882)X869 + B(883)X870 + B(884)X871 + B(885)X872 + B(886)X873 + B(887)X874 + B(888)X875 + B(889)X876 + B(890)X877 + B(891)X878 + B(892)X879 + B(893)X880 + B(894)X881 + B(895)X882 + B(896)X883 + B(897)X884 + B(898)X885 + B(899)X886 + B(900)X887 + B(901)X888 + B(902)X889 + B(903)X890 + B(904)X891 + B(905)X892 + B(906)X893 + B(907)X894 + B(908)X895 + B(909)X896 + B(910)X897 + B(911)X898 + B(912)X899 + B(913)X900 + B(914)X901 + B(915)X902 + B(916)X903 + B(917)X904 + B(918)X905 + B(919)X906 + B(920)X907 + B(921)X908 + B(922)X909 + B(923)X910 + B(924)X911 + B(925)X912 + B(926)X913 + B(927)X914 + B(928)X915 + B(929)X916 + B(930)X917 + B(931)X918 + B(932)X919 + B(933)X920 + B(934)X921 + B(935)X922 + B(936)X923 + B(937)X924 + B(938)X925 + B(939)X926 + B(940)X927 + B(941)X928 + B(942)X929 + B(943)X930 + B(944)X931 + B(945)X932 + B(946)X933 + B(947)X934 + B(948)X935 + B(949)X936 + B(950)X937 + B(951)X938 + B(952)X939 + B(953)X940 + B(954)X941 + B(955)X942 + B(956)X943 + B(957)X944 + B(958)X945 + B(959)X946 + B(960)X947 + B(961)X948 + B(962)X949 + B(963)X950 + B(964)X951 + B(965)X952 + B(966)X953 + B(967)X954 + B(968)X955 + B(969)X956 + B(970)X957 + B(971)X958 + B(972)X959 + B(973)X960 + B(974)X961 + B(975)X962 + B(976)X963 + B(977)X964 + B(978)X965 + B(979)X966 + B(980)X967 + B(981)X968 + B(982)X969 + B(983)X970 + B(984)X971 + B(985)X972 + B(986)X973 + B(987)X974 + B(988)X975 + B(989)X976 + B(990)X977 + B(991)X978 + B(992)X979 + B(993)X980 + B(994)X981 + B(995)X982 + B(996)X983 + B(997)X984 + B(998)X985 + B(999)X986 + B(1000)X987 + B(1001)X988 + B(1002)X989 + B(1003)X990 + B(1004)X991 + B(1005)X992 + B(1006)X993 + B(1007)X994 + B(1008)X995 + B(1009)X996 + B(1010)X997 + B(1011)X998 + B(1012)X999 + B(1013)X1000 + B(1014)X1001 + B(1015)X1002 + B(1016)X1003 + B(1017)X1004 + B(1018)X1005 + B(1019)X1006 + B(1020)X1007 + B(1021)X1008 + B(1022)X1009 + B(1023)X1010 + B(1024)X1011 + B(1025)X1012 + B(1026)X1013 + B(1027)X1014 + B(1028)X1015 + B(1029)X1016 + B(1030)X1017 + B(1031)X1018 + B(1032)X1019 + B(1033)X1020 + B(1034)X1021 + B(1035)X1022 + B(1036)X1023 + B(1037)X1024 + B(1038)X1025 + B(1039)X1026 + B(1040)X1027 + B(1041)X1028 + B(1042)X1029 + B(1043)X1030 + B(1044)X1031 + B(1045)X1032 + B(1046)X1033 + B(1047)X1034 + B(1048)X1035 + B(1049)X1036 + B(1050)X1037 + B(1051)X1038 + B(1052)X1039 + B(1053)X1040 + B(1054)X1041 + B(1055)X1042 + B(1056)X1043 + B(1057)X1044 + B(1058)X1045 + B(1059)X1046 + B(1060)X1047 + B(1061)X1048 + B(1062)X1049 + B(1063)X1050 + B(1064)X1051 + B(1065)X1052 + B(1066)X1053 + B(1067)X1054 + B(1068)X1055 + B(1069)X1056 + B(1070)X1057 + B(1071)X1058 + B(1072)X1059 + B(1073)X1060 + B(1074)X1061 + B(1075)X1062 + B(1076)X1063 + B(1077)X1064 + B(1078)X1065 + B(1079)X1066 + B(1080)X1067 + B(1081)X1068 + B(1082)X1069 + B(1083)X1070 + B(1084)X1071 + B(1085)X1072 + B(1086)X1073 + B(1087)X1074 + B(1088)X1075 + B(1089)X1076 + B(1090)X1077 + B(1091)X1078 + B(1092)X1079 + B(1093)X1080 + B(1094)X1081 + B(1095)X1082 + B(1096)X1083 + B(1097)X1084 + B(1098)X1085 + B(1099)X1086 + B(1100)X1087 + B(1101)X1088 + B(1102)X1089 + B(1103)X1090 + B(1104)X1091 + B(1105)X1092 + B(1106)X1093 + B(1107)X1094 + B(1108)X1095 + B

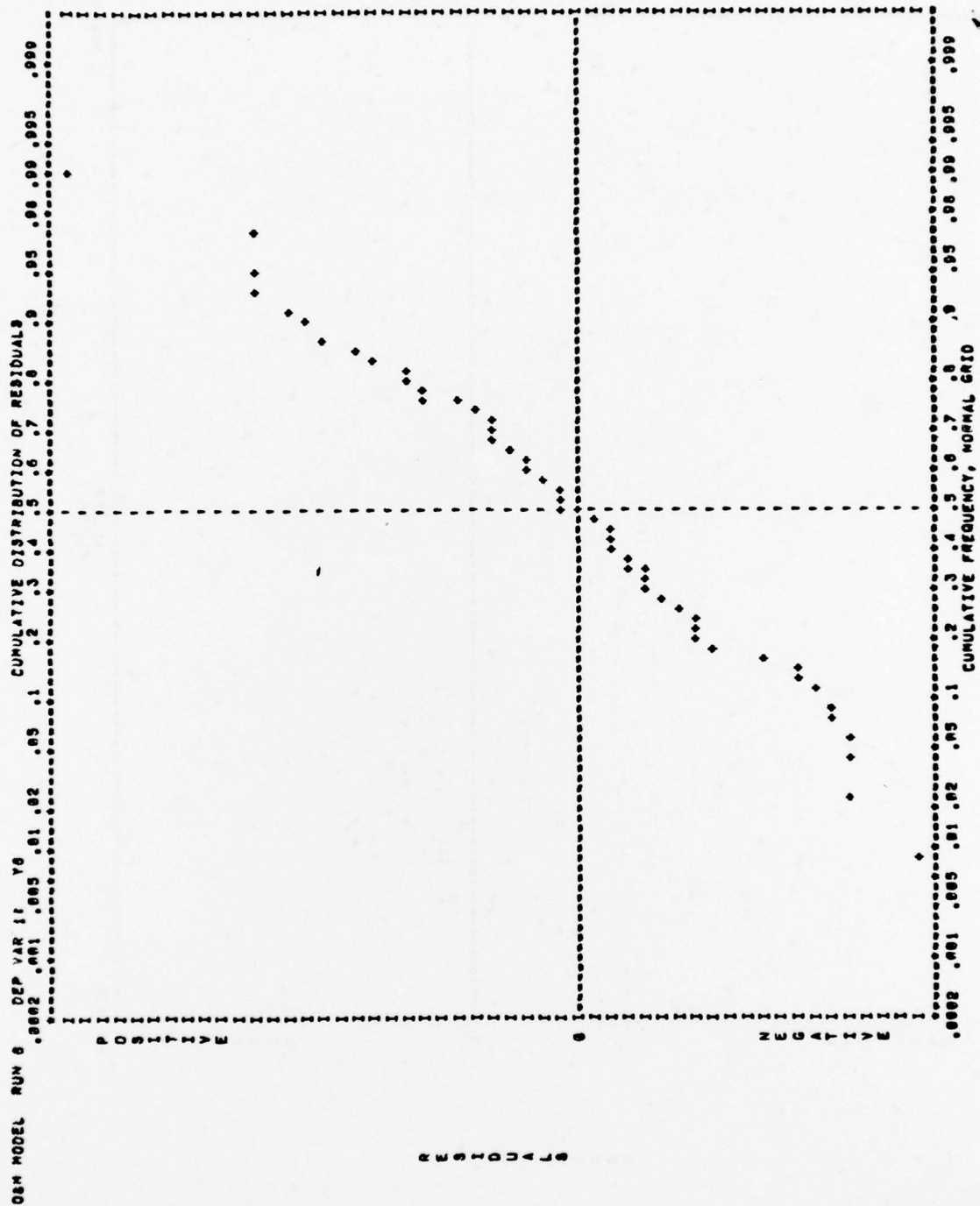
OSM MODEL RUN 6 DEP VAR 11 Y6 RESIDUAL ROOT MEAN SQUARE OF FITTED EQUATIONS 15.15
 STANDARD DEVIATION ESTIMATED FROM RESIDUALS OF NEIGHBORING OBSERVATIONS (OBSERVATIONS 1 TO 4 APART IN FITTED Y ORDER).

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM									
CUMULATIVE									
NO.	STD DEV	WSSD	OROV.	OROV.	WSSD	DEL	RESIDUALS	WSSD	DEL
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
38	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
43	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
52	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
53	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
54	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
56	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
57	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
58	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
59	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
61	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
62	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

LINEAR LEAST-SQUARES CURVE FITTING PROGRAM

IBM MODEL RUN 6 DEP VAR 11 Y6

ORDERED BY COMPUTER INPUT				ORDERED BY RESIDUALS			
IDENT.	OBSV.	WSS DISTANCE	ORF. Y	FITTED Y	RESIDUAL	OBSV.	ORF. Y
71A28	1	25	15.948	-2.948	24	192.000	65.800
71A30	2	37	15.244	8.756	26	24.000	34.200
71A32	3	35	27.000	6.359	28	180.000	21.253
71A34	4	70	16.000	24.322	30	18.000	24.037
71A36	5	37	11.000	15.917	32	27.000	20.000
71A38	6	24	6.000	-4.917	34	27.000	18.021
71A40	7	21	9.000	-5.300	36	34.000	16.760
71A42	8	18	4.000	-7.549	38	9.000	17.234
71A44	9	15	2.000	-23.230	40	17.000	16.549
71A46	10	16	24.000	-18.214	42	17.000	14.157
71A48	11	90	94.000	-2.989	44	2.000	13.430
71A50	12	92	79.100	28.537	46	6.000	11.305
71A52	13	89	11.000	-5.930	48	93.000	10.576
71A54	14	58	8.0	17.482	50	3.000	10.385
71A56	15	61	4.000	-0.811	52	5.000	10.055
71A58	16	155	6.000	23.215	54	6.100	7.214
71A60	17	161	3.000	18.107	56	5.000	6.471
71A62	18	26	180.000	65.800	58	16.000	5.643
71A64	19	165	180.000	95.245	60	67.000	5.171
71A66	20	165	3.000	-7.355	62	17.000	5.171
71A68	21	214	18.000	10.365	64	4.000	4.811
71A70	22	105	18.000	-2.680	66	4.000	4.200
71A72	23	119	8.000	-10.900	68	100.000	4.200
71A74	24	59	24.000	2.747	70	25.000	3.755
71A76	25	45	4.000	-8.208	72	18.000	3.550
71A78	26	130	16.000	10.337	74	18.000	3.131
71A80	27	130	6.000	23.750	76	90.000	2.583
71A82	28	110	34.000	-17.234	78	75.000	2.453
71A84	29	54	2.000	13.430	80	9.000	2.345
71A86	30	113	17.000	-11.430	82	30.000	2.068
71A88	31	113	8.000	9.443	84	16.000	0.750
71A90	32	45	30.000	29.132	86	3.000	0.500
71A92	33	65	4.000	17.130	88	46.000	0.000
71A94	34	40	5.000	-1.471	90	6.0	-1.345
71A96	35	177	4.000	6.661	92	8.000	-1.443
71A98	36	81	9.000	-16.402	94	6.0	-2.106
71A100	37	139	7.000	-7.093	96	4.000	-2.061
71A102	38	62	5.000	-5.055	98	5.200	-2.750
71A104	39	132	25.000	21.442	100	13.000	-2.940
71A106	40	120	93.000	62.324	102	94.000	-2.000
71A108	41	59	2.100	-2.100	104	4.000	-2.150
71A110	42	307	46.000	46.000	106	15.000	-2.595
71A112	43	200	50.000	47.317	108	17.000	-4.700
71A114	44	234	15.000	10.305	110	11.000	-4.917
71A116	45	187	18.000	14.000	112	5.000	-4.973
71A118	46	189	9.000	26.407	114	10.000	-5.171
71A120	47	42	6.000	6.000	116	11.000	-5.030
71A122	48	52	17.000	21.708	118	5.700	-6.307
71A124	49	61	75.000	72.547	120	1.000	-7.113
71A126	50	213	15.171	-5.171	122	0.0	-7.093
71A128	51	111	67.000	61.000	124	10.000	-6.322
71A130	52	40	4.000	7.950	126	2.000	-6.453
71A132	53	40	5.200	-7.950	128	2.000	-6.453
71A134	54	32	6.700	-9.760	130	6.700	-9.760
71A136	55	50	17.200	3.043	132	4.000	-13.120
71A138	56	52	2.000	18.453	134	3.000	-15.107
71A140	57	52	2.000	18.453	136	0.000	-15.315
71A142	58	48	5.700	12.007	138	10.000	-15.407
71A144	59	63	5.000	16.373	140	8.0	-17.402
71A146	60	63	3.000	2.500	142	8.0	-17.402
71A148	61	45	2.000	1.224	144	9.000	-17.750
71A150	62	35	1.000	0.913	146	24.000	-18.214
71A152	63	37	0.100	0.000	148	8.000	-18.000
71A154	64	240	0.0	1.345	150	4.000	-20.320



Q&M MODEL RUN 6 DEP VAR 11 Y6

RESIDUAL VS. FITTED Y
42.779

11.430

42,779

00,000

POSITIVE

NEGATIVE

011-438

13-779

98-089
-44-

**42.779
FITTED Y**

[illegible]

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